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Kitago et al.

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(54) **BELT CONVEYANCE APPARATUS AND IMAGE FORMING APPARATUS FOR REDUCED BELT BUCKLING**

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***G03G 15/16*** (2006.01)

(52) **U.S. Cl.**
CPC ................................ ***G03G 15/1615*** (2013.01)

(58) **Field of Classification Search**
CPC .................................................. G03G 15/1615
USPC .......................................................... 399/302
See application file for complete search history.

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(57) **ABSTRACT**

A belt conveyance apparatus includes an endless belt conveyed while being supported by a plurality of support rollers in a tensioned state. The plurality of support rollers include a tension roller and a steering roller. The tension roller, which is disposed adjacent to and downstream of the steering roller in a conveyance direction of the endless belt, has a reverse crown shape in which end portions in a rotational axis direction each have an outer diameter larger than a middle portion.

**19 Claims, 10 Drawing Sheets**

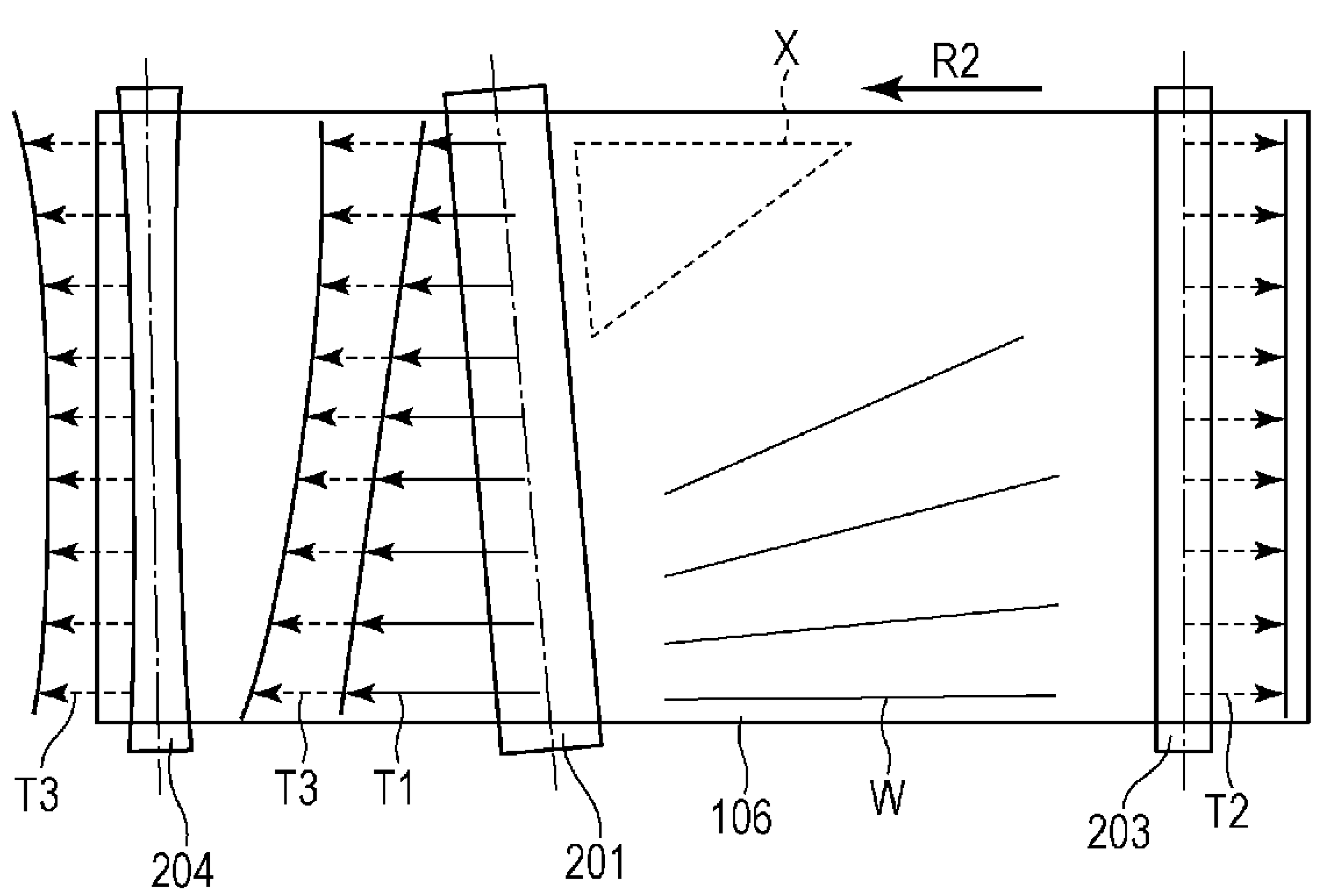


FIG. 1

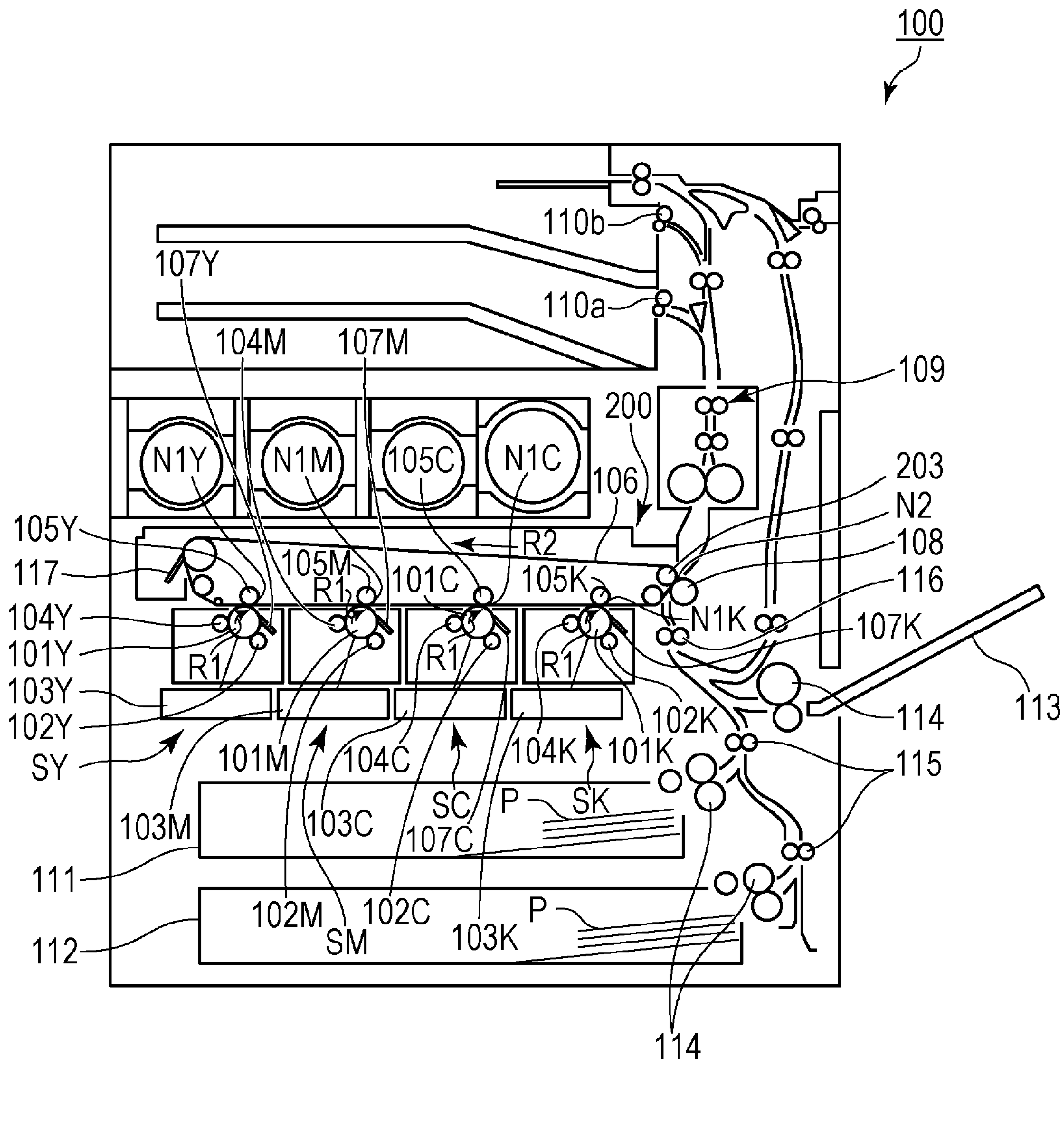
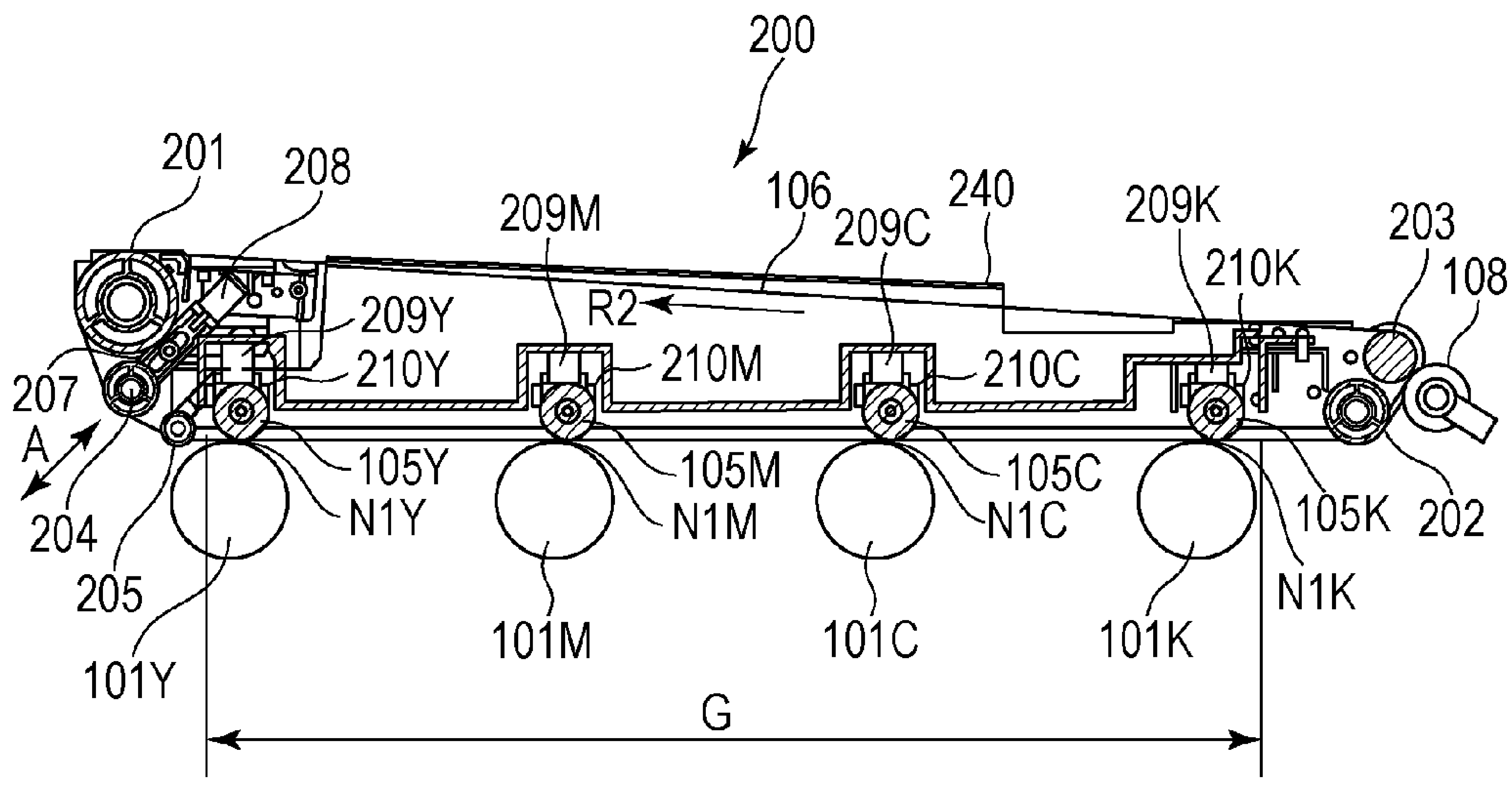

100
110b
107Y
110a
104M
107M
109
200
N1Y
N1M
105C
N1C
106
203
N2
105Y
R2
108
117
105M
R1
101C
105K
116
104Y
N1K
107K
101Y
R1
R1
R1
103Y
102K
114
113
102Y
101M
104C
104K
101K
115
SY
SC
P
SK
103M
103C
107C
111
102M
102C
P
112
SM
103K
114

FIG. 2



200
201
208
106
240
209M
209C
209K
203
108
210K
R2
209Y
210Y
210M
210C
207
A
204
205
105Y
N1Y
105M
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105C
N1C
105K
202
N1K
101Y
101M
101C
101K
G

FIG. 3

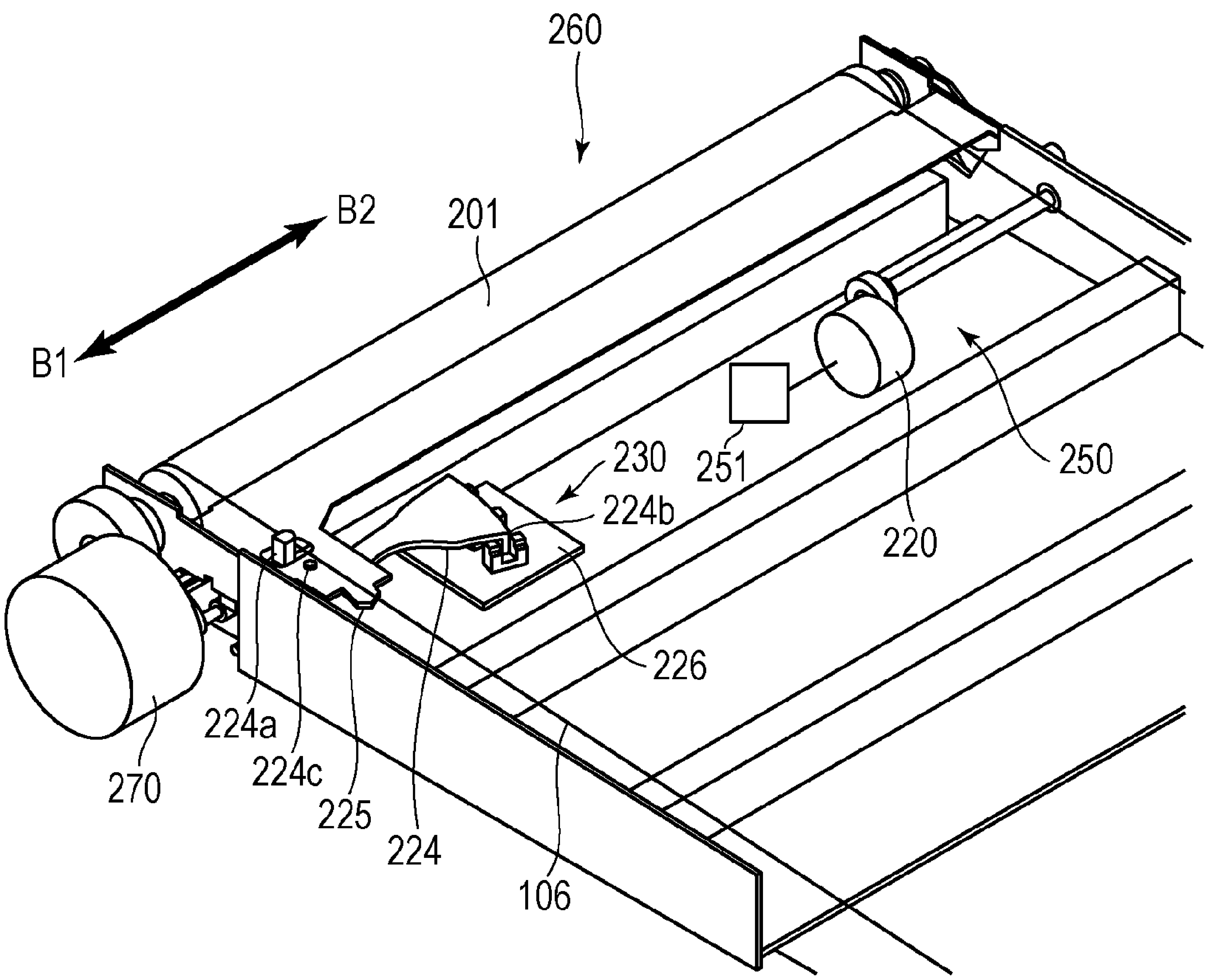


FIG. 4A

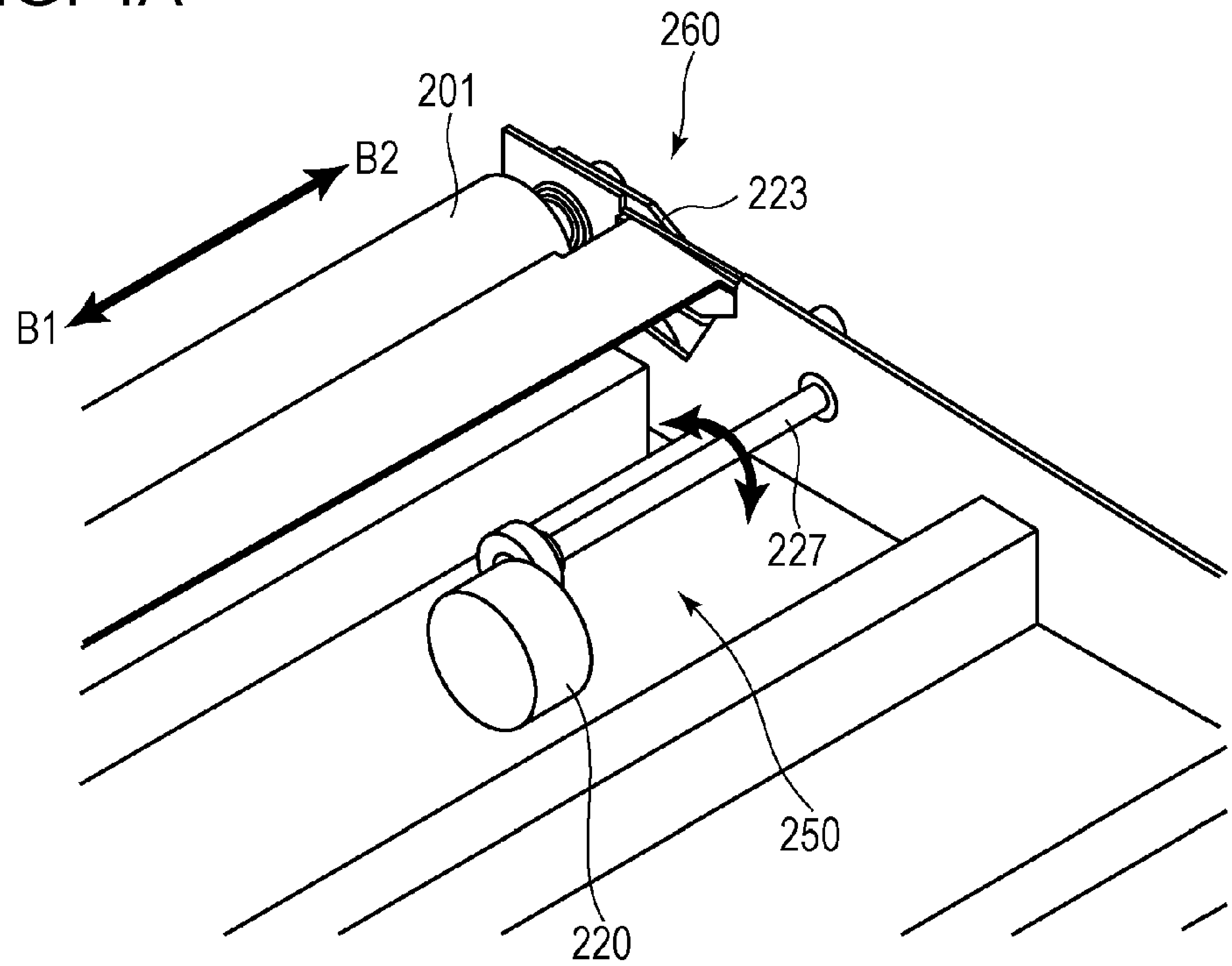

260
201
B2
223
B1
227
250
220

FIG. 4B

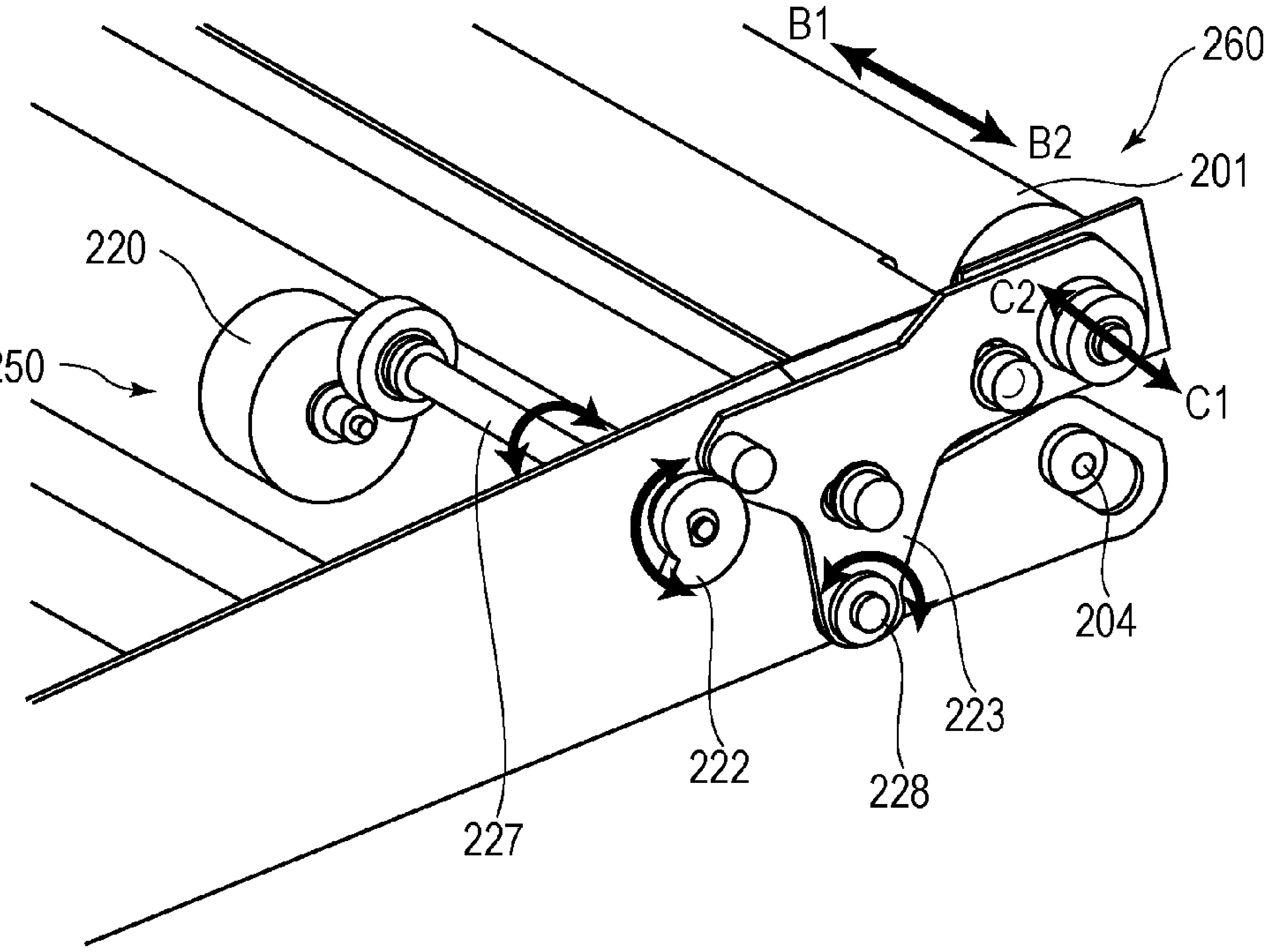

B1
260
B2
201
220
C2
250
C1
204
222
223
228
227

FIG. 5A

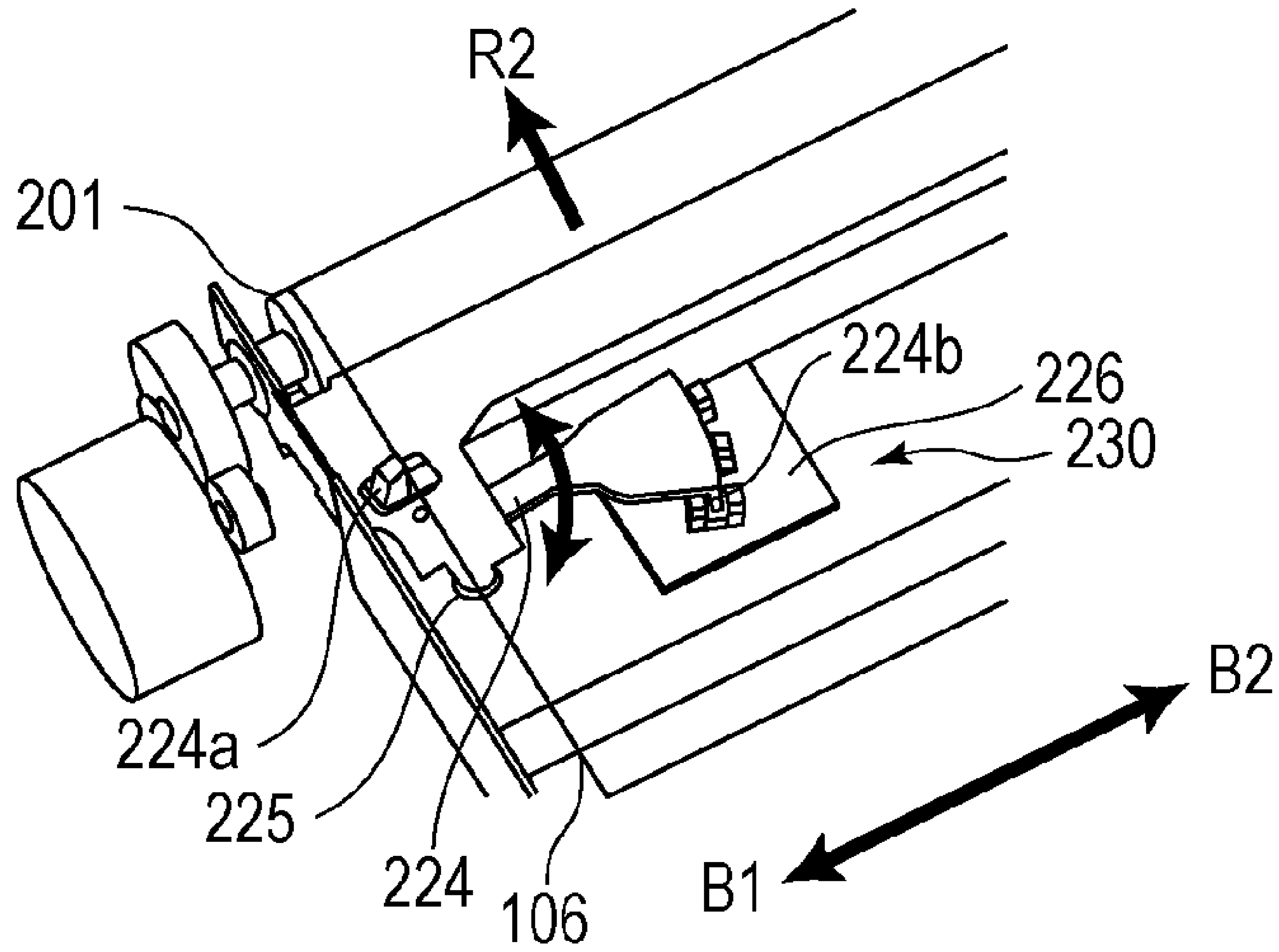



FIG. 5B

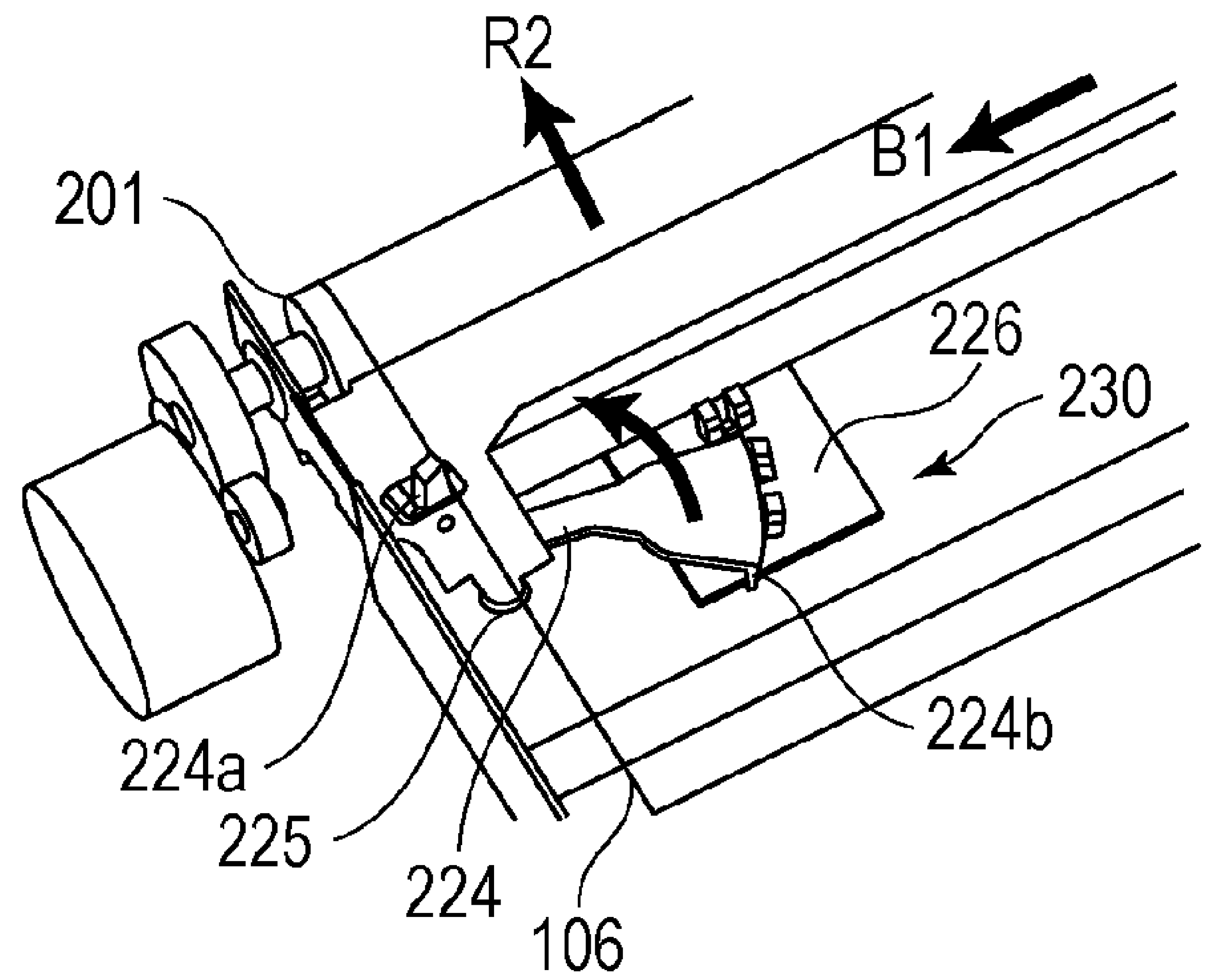



FIG. 5C

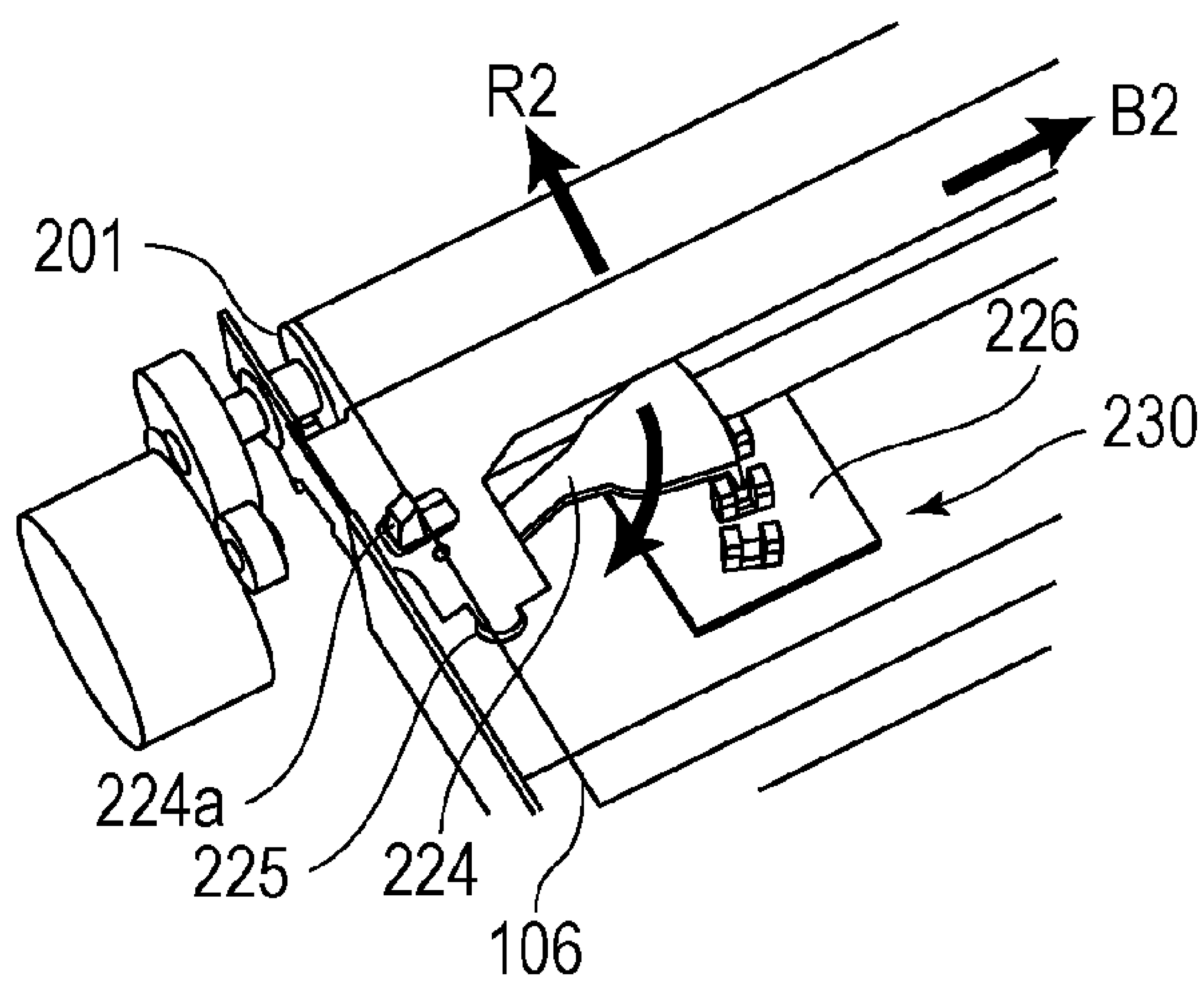


FIG. 6A

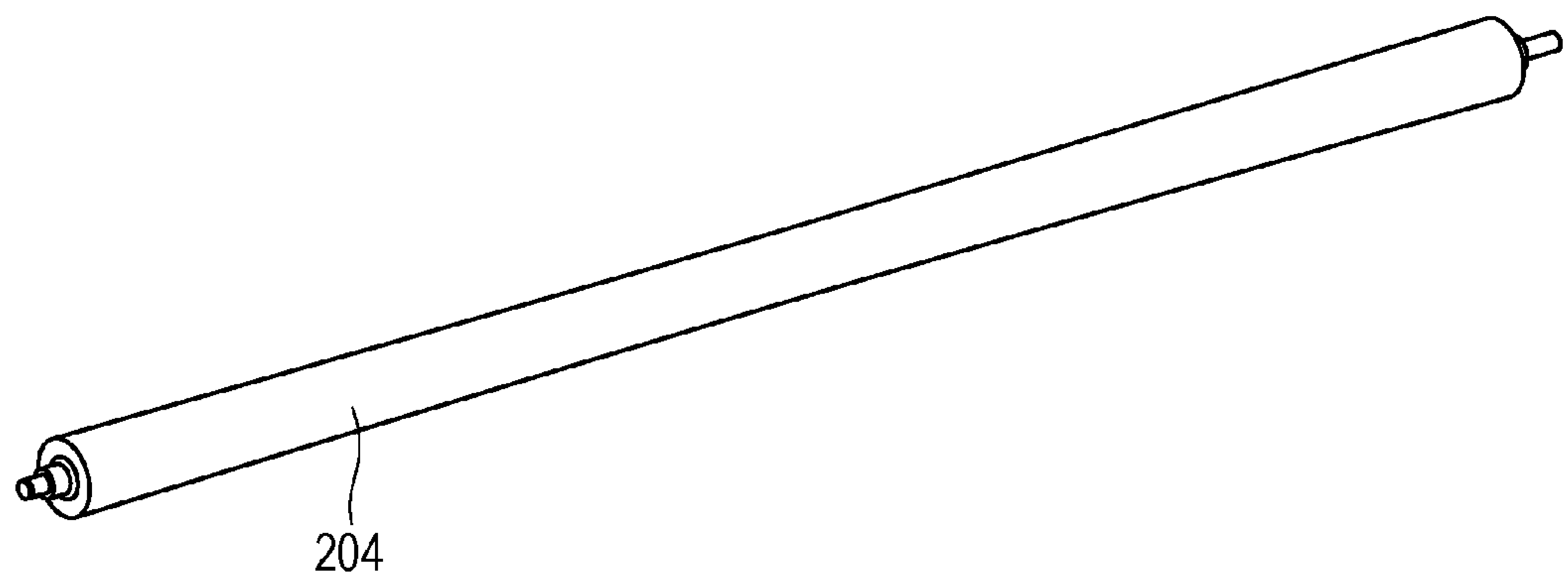



FIG. 6B

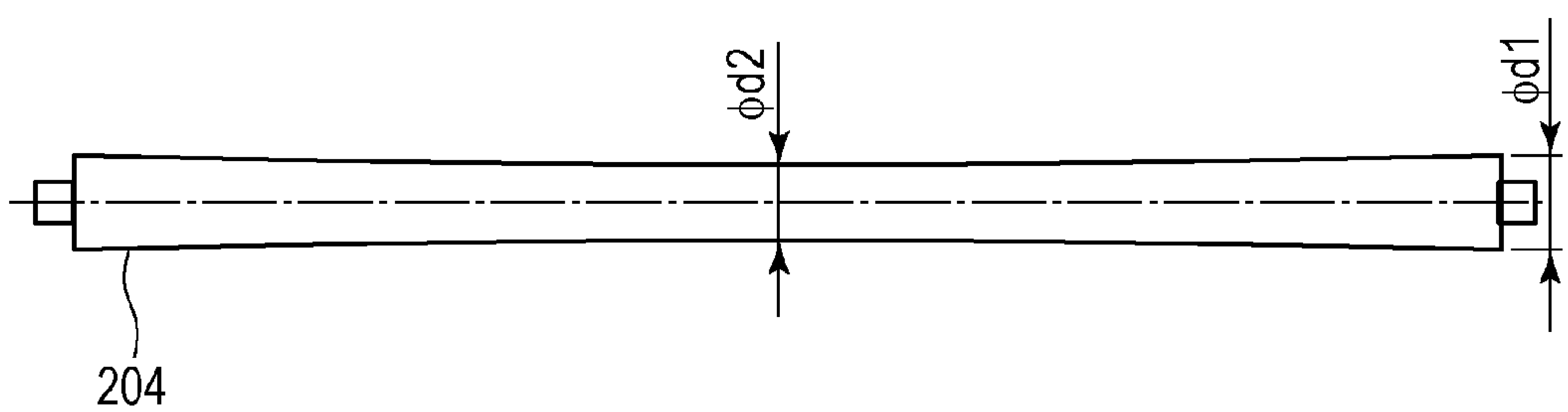


FIG. 7

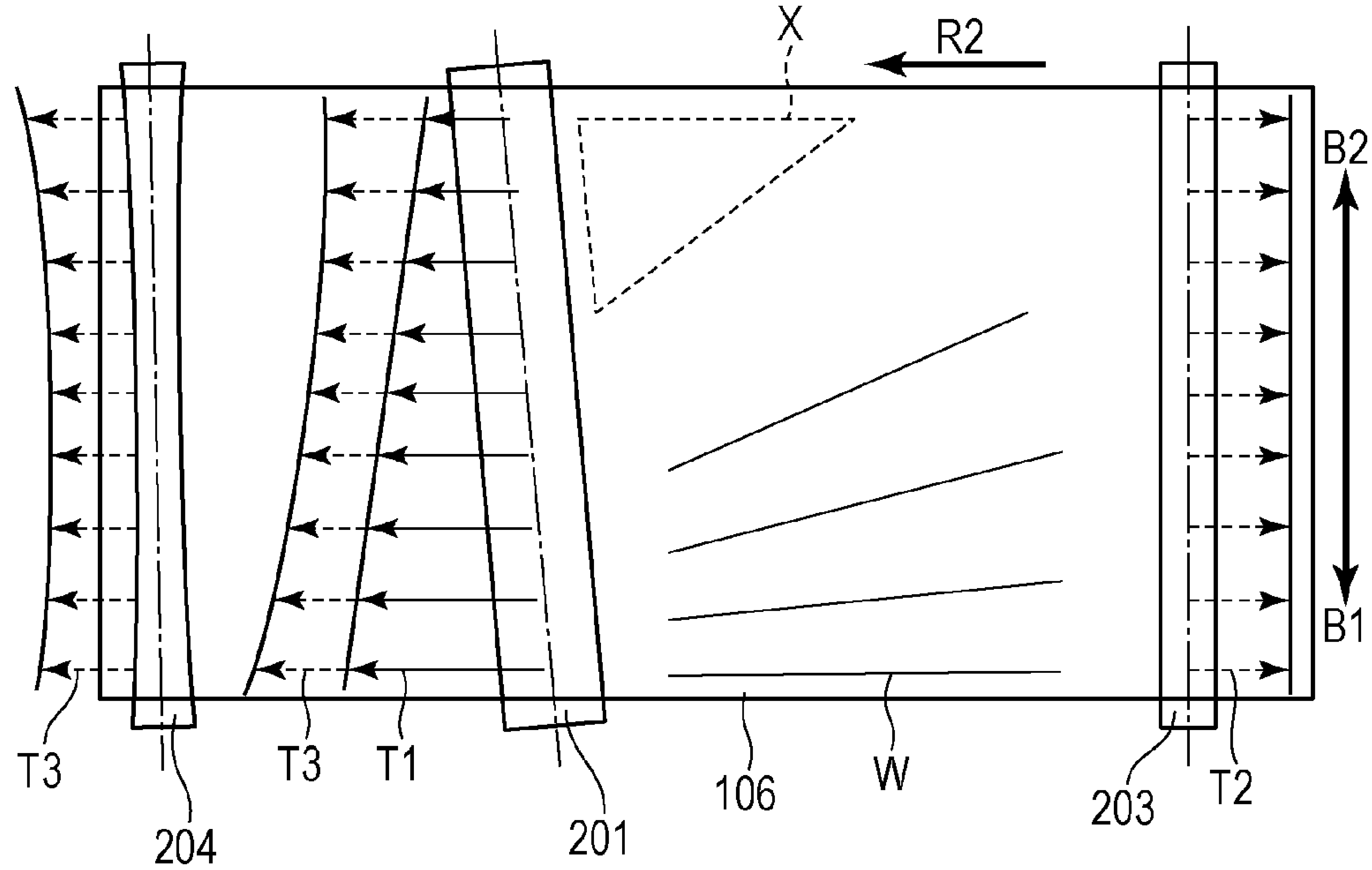

X
R2
B2
B1
T3
T3
T1
204
201
106
W
203
T2

FIG. 8

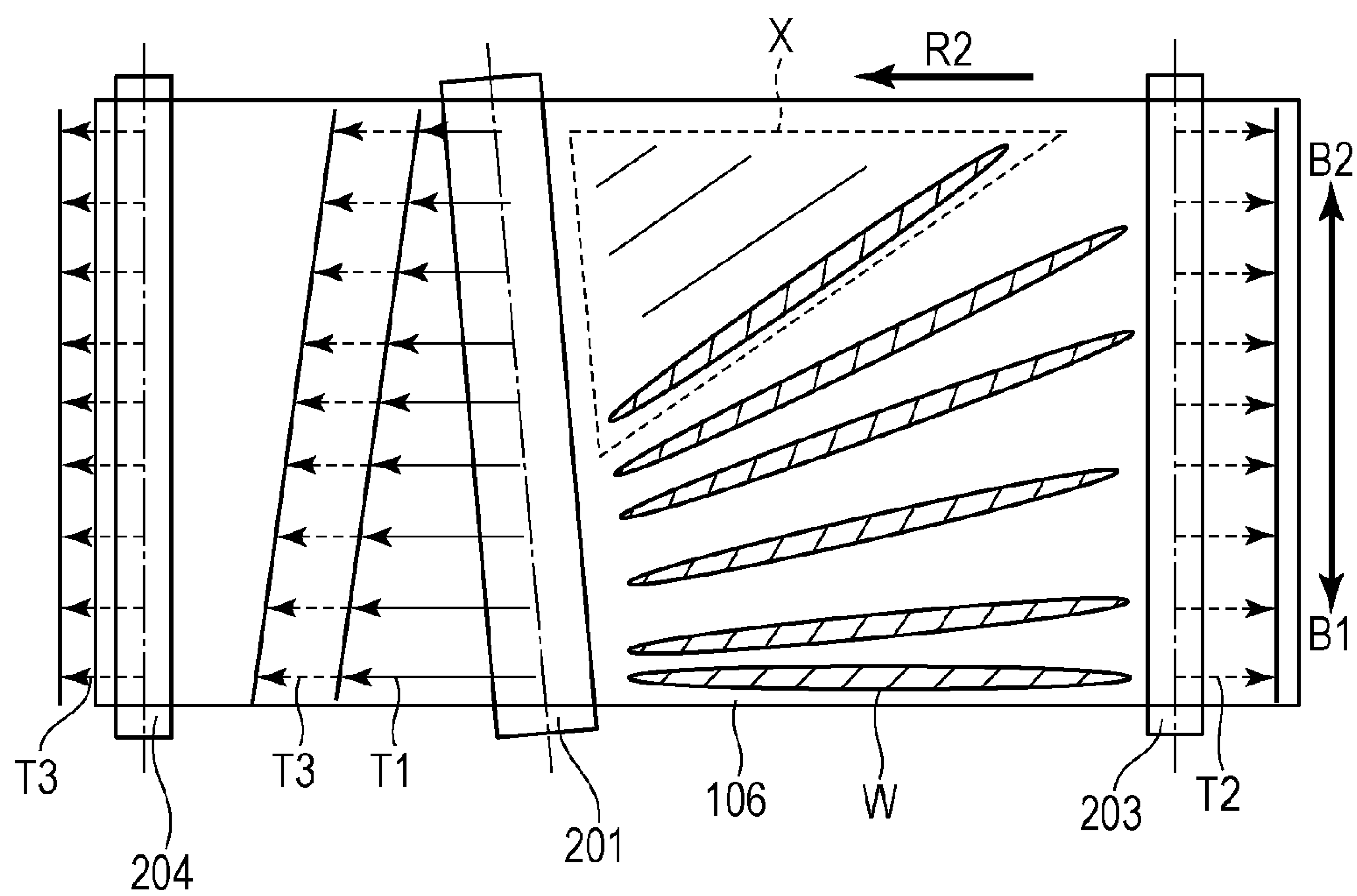

X
R2
B2
B1
T3
T3
T1
204
201
106
W
203
T2

FIG. 9A

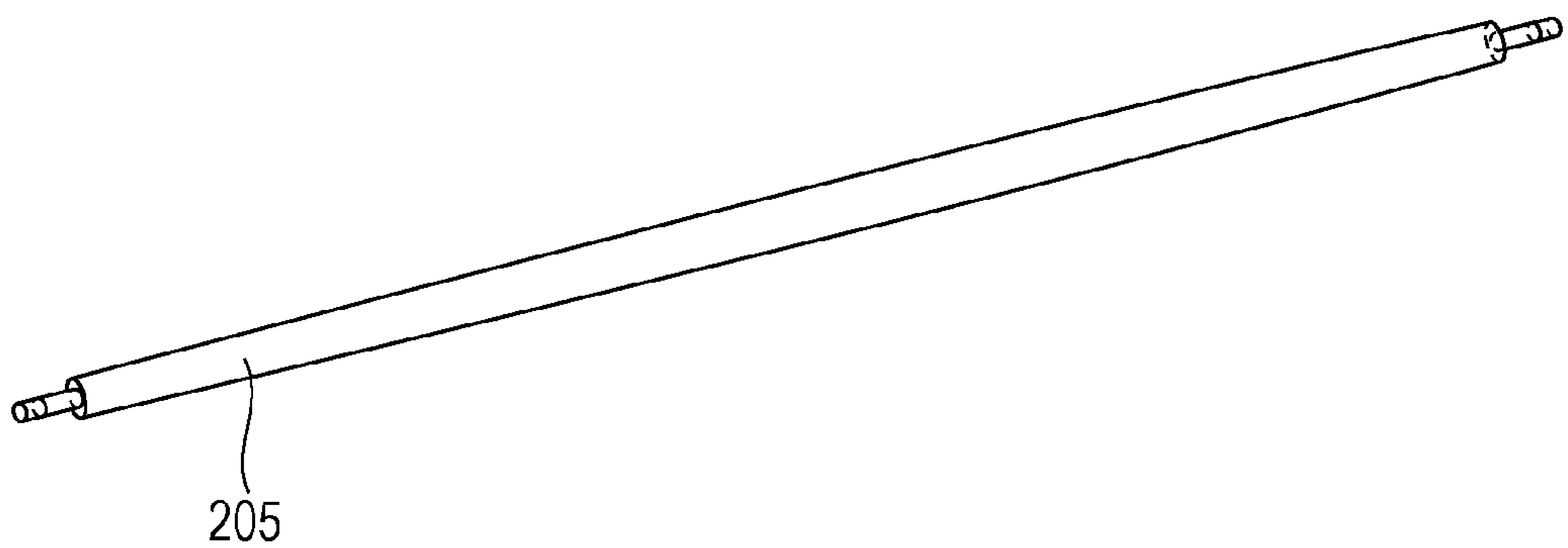



FIG. 9B

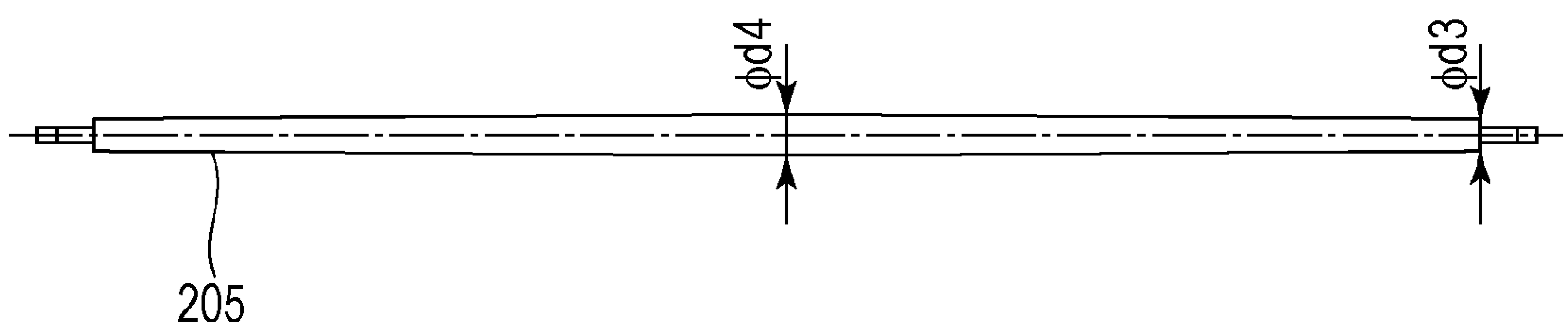


FIG. 10

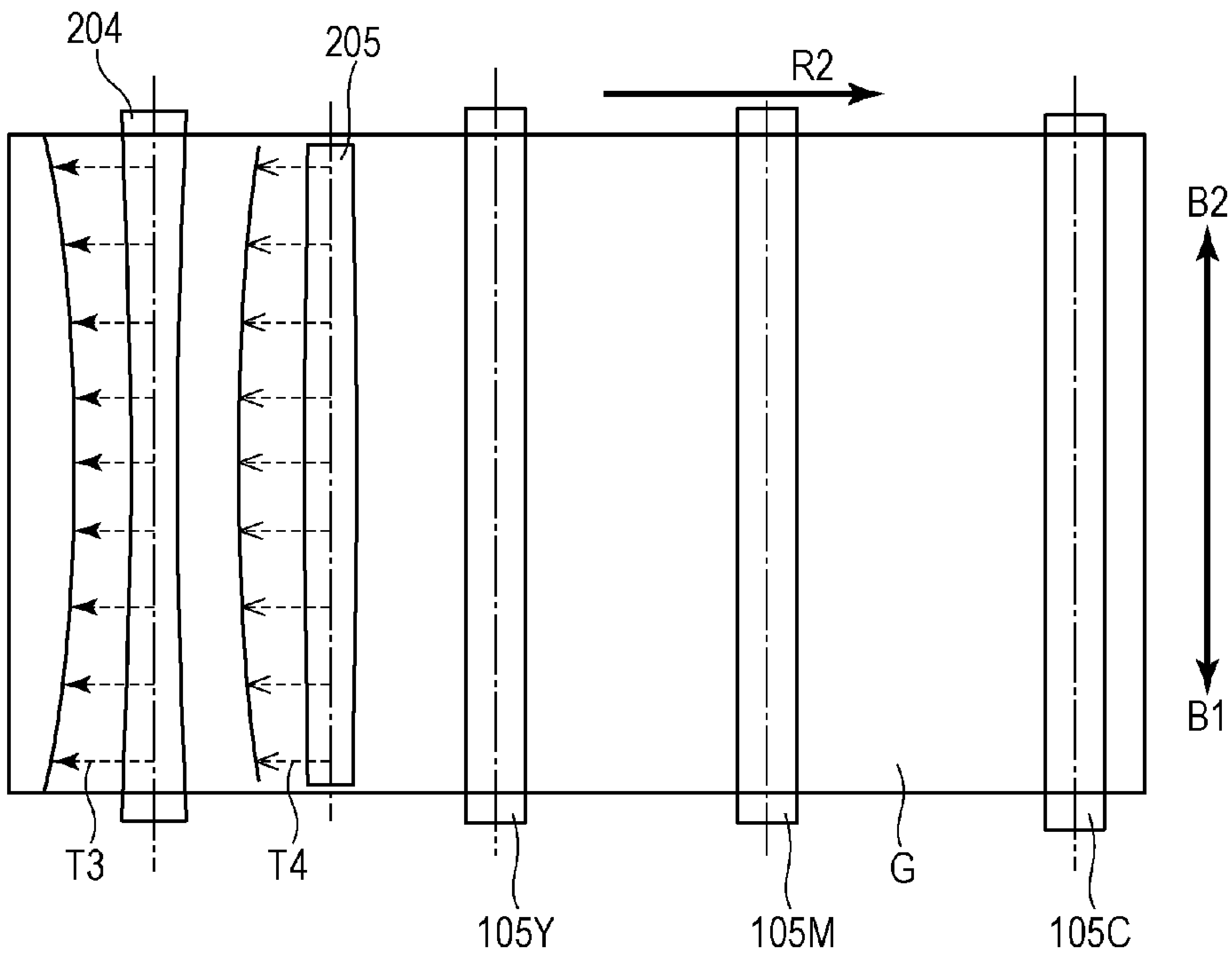

204
205
R2
B2
B1
T3
T4
105Y
105M
G
105C

FIG. 11

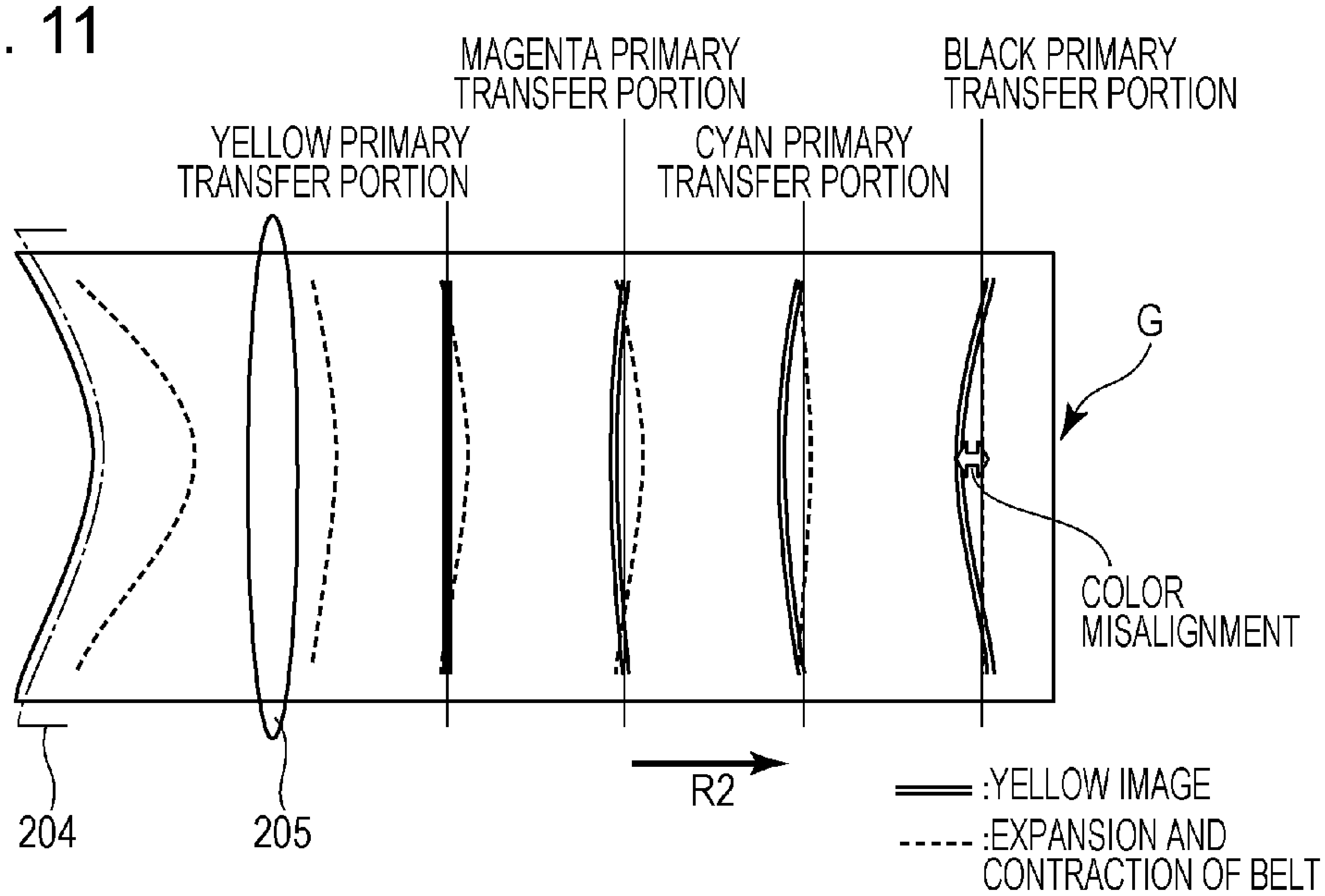

MAGENTA PRIMARY TRANSFER PORTION
BLACK PRIMARY TRANSFER PORTION
YELLOW PRIMARY TRANSFER PORTION
CYAN PRIMARY TRANSFER PORTION
G
COLOR MISALIGNMENT
204
205
R2
:YELLOW IMAGE
:EXPANSION AND CONTRACTION OF BELT

FIG. 12

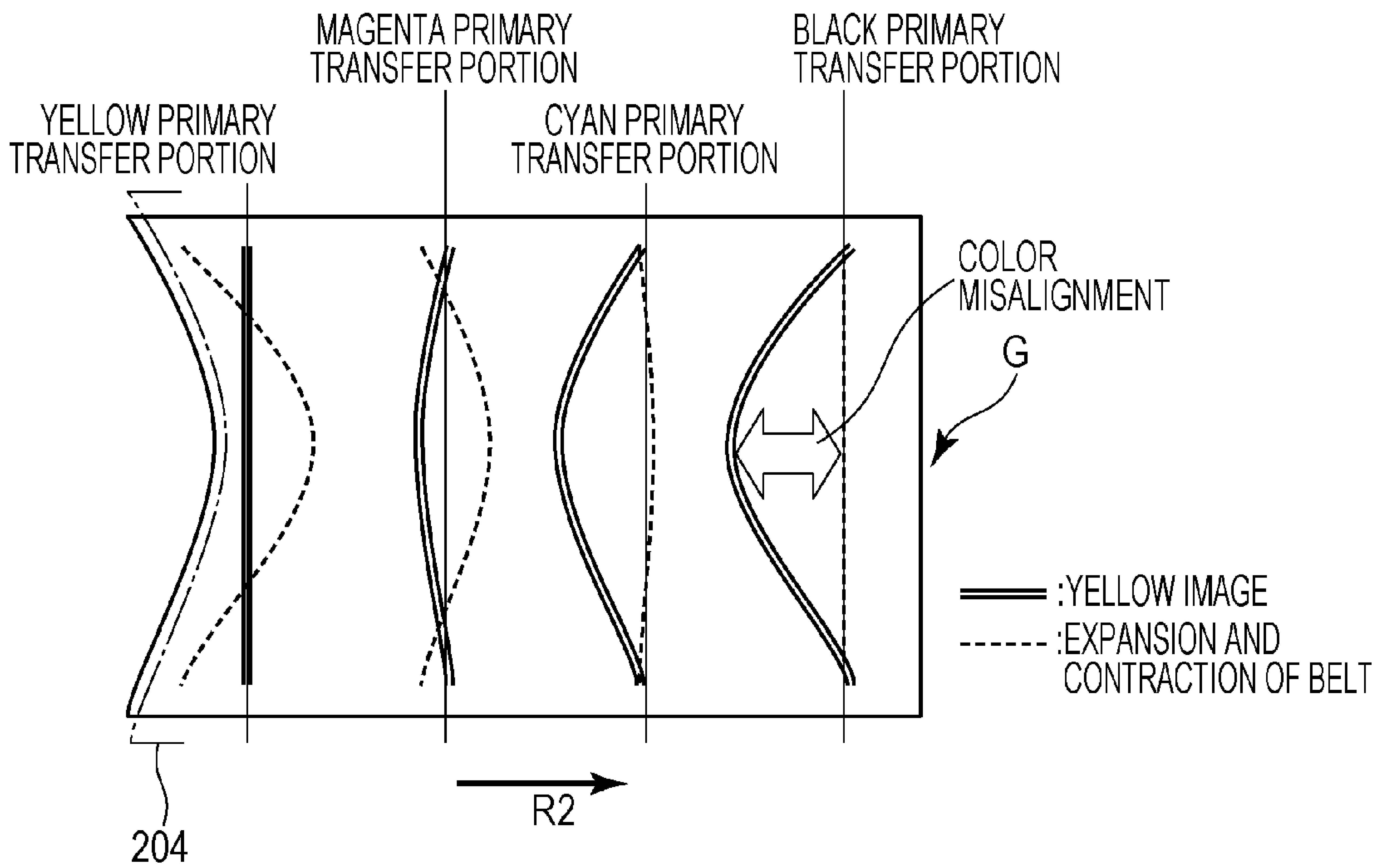
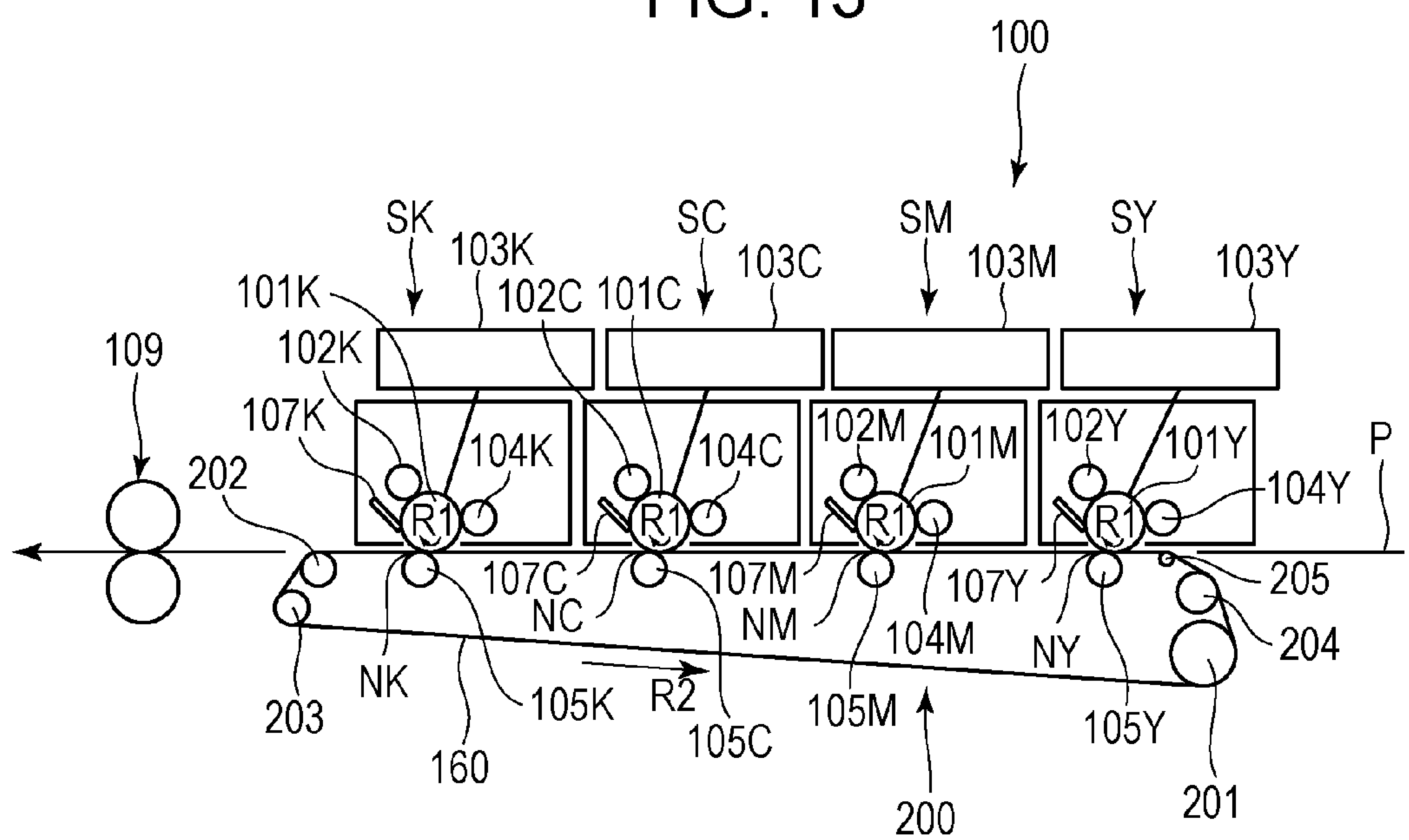

MAGENTA PRIMARY TRANSFER PORTION
BLACK PRIMARY TRANSFER PORTION
YELLOW PRIMARY TRANSFER PORTION
CYAN PRIMARY TRANSFER PORTION
COLOR MISALIGNMENT
G
:YELLOW IMAGE
:EXPANSION AND CONTRACTION OF BELT
R2
204

FIG. 13


100
SK
SC
SM
SY
103K
103C
103M
103Y
101K
102C
101C
109
102K
107K
104K
104C
102M
101M
102Y
101Y
104Y
P
202
R1
107C
NC
107M
NM
107Y
104M
NY
205
204
203
NK
105K
R2
105C
105M
105Y
160
200
201

# BELT CONVEYANCE APPARATUS AND IMAGE FORMING APPARATUS FOR REDUCED BELT BUCKLING

## BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a belt conveyance apparatus used in an image forming apparatus such as a copier using an electrophotography process or an electrostatic recording process, a printer, and a facsimile, and an image forming apparatus including the belt conveyance apparatus.

Description of the Related Art

An image forming apparatus using an electrophotography process or an electrostatic recording process, for example, typically includes a belt conveyance apparatus including an endless belt (hereinafter, may be simply referred to as a "belt") supported by a plurality of support rollers in a tensioned state. The belt is used as a carrier that carries and conveys a toner image or a recording medium on which a toner image is formed. Examples of the carrier that carries and conveys a toner image include a belt-shaped electrophotographic sensitive member (photosensitive belt) and an intermediate transfer member (intermediate transfer belt) configured to carry and convey a toner image transferred from a photoconductor to transfer the toner image onto a recording medium. Examples of the carrier that carries and conveys a recording medium on which a toner image is formed include a recording medium carrier (conveyance belt) configured to carry and convey a recording medium to which the toner image is transferred from the photoconductor.

An example of the image forming apparatus using an electrophotography process, which includes an intermediate transfer belt, is further described. In general, the intermediate transfer belt configured to be supported by a plurality of support rollers in a tensioned state and rotated (conveyed) may be displaced toward one end in the width direction, which is a direction substantially perpendicular to a conveyance direction, during the rotation. This problem is called "belt deviation (meandering)". The belt deviation may be caused by factors, such as a low outer diameter accuracy of each support roller and low relative alignment accuracy between the support rollers.

As a measure to solve the problem of the belt deviation, Japanese Patent Laid-Open No. 2002-2999 discloses a technique in which at least one of support rollers is tilted against the other support rollers to move the intermediate transfer belt in a direction opposite to the direction of displacement in the width direction of the intermediate transfer belt.

However, when the steering roller is tilted on a predetermined trajectory as described in Japanese Patent Laid-Open No. 2002-2999, the tilting may destroy the parallel relationship between the steering roller and the other support rollers in the conveyance direction of the intermediate transfer belt. This may cause a stretched surface of the intermediate transfer belt to have a difference in tension in the width direction of the intermediate transfer belt at a position adjacent to a portion wound around the steering roller. Thus, in particular, the stretched surface of the intermediate transfer belt between the steering roller and the support roller (upstream roller), which is positioned adjacent to and upstream of the steering roller in the conveyance direction of the intermediate transfer belt, is readily waved. The wave typically extends radially from a high-tensioned portion of the stretched surface, which is close to the steering roller, toward an upstream side of the intermediate transfer belt in the conveyance direction of the intermediate transfer belt.



If the intermediate transfer belt is waved while traveling, the wave generally disappears at the portion of the intermediate transfer belt to be wound around the steering roller. However, if the wave protrudes such that the height of the wave is larger than the width of the wave, the intermediate transfer belt may be buckled at the portion to be wound around the steering roller. As a result, the intermediate transfer belt may have a crease. If the intermediate transfer belt has a crease, an output image may have a crease, resulting in an image defect. In addition, once the intermediate transfer belt has a crease, the crease is unlikely to be readily smoothed out.

## SUMMARY OF THE INVENTION

The present invention provides a belt conveyance apparatus including

an endless belt carrying a toner image and

a plurality of support rollers supporting the endless belt from an inner surface side of the endless belt in a tensioned state, the plurality of support rollers including a steering roller, a first roller, and a second roller, wherein

the steering roller is configured to move the endless belt in a width direction of the endless belt when tilted with respect to the first roller, the width direction intersecting a traveling direction of the endless belt,

the first roller is disposed adjacent to and upstream of the steering roller in the traveling direction of the endless belt, and

the second roller is disposed adjacent to and downstream of the steering roller in the traveling direction of the endless belt, the second roller having a reverse crown shape in which end portions in a rotational axis direction each have a larger outer diameter than a middle portion.

The present invention also provides an image forming apparatus including

an endless belt,

a toner image forming unit configured to form a toner image on the endless belt, and

a plurality of support rollers supporting the endless belt from an inner surface side of the endless belt in a tensioned state, the plurality of support rollers including a steering roller, a first roller, and a second roller, wherein

the steering roller is configured to move the endless belt in a width direction of the endless belt when tilted with respect to the first roller, the width direction intersecting a traveling direction of the endless belt,

the first roller is disposed adjacent to and upstream of the steering roller in the traveling direction of the endless belt, and

the second roller is disposed adjacent to and downstream of the steering roller in the traveling direction of the endless belt, the second roller having a reverse crown shape in which end portions in a rotational axis direction each have a larger outer diameter than a middle portion.

Further features of the present invention will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic cross-sectional view of an image forming apparatus.

FIG. **2** is a schematic cross-sectional view of an intermediate transfer unit.

FIG. **3** is a schematic perspective view of a steering roller and peripheral portions thereof.

FIGS. **4**A and **4**B are schematic perspective views of a steering drive unit and peripheral portions thereof.

FIGS. **5**A to **5**C are schematic perspective views indicating an operation of a steering mechanism.

FIGS. **6**A and **6**B are respectively a perspective view and a cross-sectional view of a tension roller according to an embodiment of the present invention.

FIG. **7** is a schematic view indicating a tension distribution in an intermediate transfer belt according to an embodiment of the present invention.

FIG. **8** is a schematic view indicating a tension distribution in an intermediate transfer belt according to a comparative example.

FIGS. **9**A and **9**B are respectively a perspective view and a cross-sectional view of an auxiliary roller according to another embodiment of the present invention.

FIG. **10** is a schematic view indicating a tension distribution in an intermediate transfer belt at a position close to an image transfer surface according to another embodiment of the present invention.

FIG. **11** is a schematic view indicating a relationship between expansion and contraction of the intermediate transfer belt and an image according to another embodiment of the present invention.

FIG. **12** is a schematic view for explaining a generation mechanism of color misalignment.

FIG. **13** is a schematic cross-sectional view of the main components of an image forming apparatus according to one of other embodiments.

## DESCRIPTION OF THE EMBODIMENTS

Hereinafter, a belt conveyance apparatus and an image forming apparatus according to the present invention are described further in detail with reference to the drawings.

### First Embodiment

#### 1. Overall Configuration and Operation of Image Forming Apparatus

FIG. **1** is a schematic cross-sectional view of an image forming apparatus according to an embodiment of the present invention. An image forming apparatus **100** of this embodiment is a tandem color digital printer using an intermediate transfer process. The image forming apparatus **100** is configured to form a color image by using an electrophotography process.

The image forming apparatus **100** includes first, second, third, and fourth image forming sections SY, SM, SC, and SK configured to form images in yellow (Y), magenta (M), cyan (C), and black (K), respectively, as a plurality of image forming sections (stations). In this embodiment, the image forming sections SY, SM, SC, and SK are substantially the same in the configuration and the operation, except that each image forming section SY, SM, SC, and SK uses a toner in a different color in a development step. Hereinafter, when the image forming sections SY, SM, SC, and SK do not need to be distinguished from each other, the suffixes Y, M, C, and K, which indicate the colors, may be omitted and the image forming sections are collectively described.

Each image forming section S includes a photosensitive drum **101**, which is a drum type electrophotographic photoconductive member (photoconductor), as an image carrier. The photosensitive drum **101** is configured to rotate in a direction indicated by an arrow R**1** in FIG. **1**. In the image forming section S, the following various devices are disposed around the photosensitive drum **101**. The various devices include a charging roller **102**, which is a roller type charging member as a charging unit, a laser scanner **103** as an exposing unit, a developer **104** as a developing unit, a primary transfer roller **105**, which is a roller type primary transfer member as a primary transfer unit, and a drum cleaner **107** as a photoconductor cleaning unit.

The charging roller **102** is configured to substantially uniformly charge the surface of the rotating photosensitive drum **101** to a predetermined potential of predetermined polarity (negative polarity in this embodiment). The charged surface of the photosensitive drum **101** is exposed to a light emitted by the laser scanner **103** in accordance with an image signal, and thus a latent image (electrostatic image) corresponding to the image signal is formed on the photosensitive drum **101**. The laser scanner **103** is configured to receive an image signal corresponding to the image forming section S and apply a laser light to the surface of the photosensitive drum **101** in accordance with the image signal so as to neutralize the charge on the photosensitive drum **101** and form a latent image. The latent image formed on the photosensitive drum **101** is developed by the developer **104** using a toner as a developing agent. In this embodiment, a toner charged to the same polarity as the charge polarity of the photosensitive drum **101** (negative polarity in this embodiment) is attached to an exposed portion of the photosensitive drum **101** where the absolute value of the potential is lowered by being exposed to the light after uniformly charged (reverse development).

The image forming apparatus **100** includes an intermediate transfer belt **106**, which is an intermediate transfer member composed of an endless belt, so as to face the photosensitive drums **101** in the image forming sections S. The intermediate transfer belt **106** is configured to rotate in a direction indicated by an arrow R**2** in FIG. **1**. The primary transfer rollers **105** are positioned on an inner surface side of the intermediate transfer belt **106** so as to face the photosensitive drums **101** in the image forming sections S. The primary transfer rollers **105** are biased (pressed) against the photosensitive drums **101** with the intermediate transfer belt **106** therebetween to form primary transfer portions (primary transfer nips) N**1** where the intermediate transfer belt **106** and the photosensitive drums **101** are in contact with each other. In addition, a secondary transfer roller **108**, which is a roller type secondary transfer member as a secondary transfer unit, is disposed on an outer surface side of the intermediate transfer belt **106** so as to face a secondary transfer opposing roller **203**, which is one of the support rollers supporting the intermediate transfer belt **106** in a tensioned state. The secondary transfer roller **108** is biased (pressed) against the secondary transfer opposing roller **203** with the intermediate transfer belt **106** therebetween to form a secondary transfer portion (secondary transfer nip) N**2** where the intermediate transfer belt **106** and the secondary transfer roller **108** are in contact with each other. The primary transfer roller **105**, the intermediate transfer belt **106**, and the plurality of support rollers, which support the intermediate transfer belt **106** in a tensioned state, for example, constitute an intermediate transfer unit **200**, which is a belt conveyance apparatus in this embodiment. The intermediate transfer unit **200** is described further in detail later.

The toner image formed on the photosensitive drum **101** is electrostatically transferred (primary transferred) onto the rotating intermediate transfer belt **106** by the primary transfer roller **105** at the primary transfer portion N1. At this time, the primary transfer roller **105** is supplied with a primary transfer bias of the polarity opposite the charge polarity of the toner during the development (regular charge polarity). In the case of the formation of a full-color image, for example, which is described later, the toner images in different colors formed on the corresponding photosensitive drums **101** in the image forming sections S are sequentially transferred onto the intermediate transfer belt **106** at the primary transfer portions N1 so as to overlap with each other. As a result, a multilayered toner image for a full color image is formed on the intermediate transfer belt **106**. A residual toner remaining on the photosensitive drum **101** after the primary transfer step (untransferred toner in the primary transfer) is removed from the photosensitive drum **101** by the drum cleaner **107** and collected.

A recording material (image receiving medium, recording medium, sheet) P such as paper sent from a cassette **111**, **112**, or manual tray **113** is sent to a resist roller **116** by a feeding roller **114** or a transportation roller **115**, for example. Then, after an end of the recording material P comes in contact with the stopped resist roller **116** and forms a loop, the resist roller **116** start rotating in synchronization with the toner image on the intermediate transfer belt **106** to transport the recording medium P to the secondary transfer portion N2.

The toner image on the intermediate transfer belt **106** is electrostatically transferred (secondary transferred) onto the recording medium P by the secondary transfer roller **108** at the secondary transfer portion N2. At this time, the secondary transfer roller **108** is supplied with a secondary transfer bias of the polarity opposite to the charge polarity of the regular charge polarity of the toner. A residual toner remaining on the intermediate transfer belt **106** after the secondary transfer step (untransferred toner in the secondary transfer) is removed from the intermediate transfer belt **106** by a belt cleaner **117** and collected.

The recording material P to which the toner image is transferred is sent to a fixing device **109** as a fixing unit where the toner image is fixed on the recording material P by heat and pressure. Then, the recording material P is ejected to the outside of the image forming apparatus **100** through one of ejection portions **110***a* and **110***b*.

In this embodiment, the image forming sections SY, SM, SC, and SK constitute a toner image forming unit configured to form a toner image on the intermediate transfer belt **106**.

## 2. Intermediate Transfer Unit

Next, a schematic configuration of the intermediate transfer unit **200** as the belt conveyance apparatus in this embodiment is described.

Here, a direction (width direction) substantially perpendicular to the conveyance direction (traveling direction) of the intermediate transfer belt **106** may be also referred to as a thrust direction. The thrust direction is substantially parallel to a direction of a rotation axis of each of the photosensitive drums **101** and the support rollers **201** to **205**. A "front side" and "rear side" of the image forming apparatus **100** are respectively a side facing to the viewer and a side facing away from the viewer in the thrust direction in FIG. **1**. In addition, an up-down direction of the image forming apparatus **100** is an up-down direction in the vertical direction, but not limited to a straight up and down direction, and may include an obliquely above and below the horizontal at a reference position or reference component. In addition, when the positional relationship between positions or components in the image forming apparatus **100** is described, the image forming apparatus **100** is regarded as being set in a normal position.

FIG. **2** is a schematic cross-sectional view of the intermediate transfer unit **200** (the photosensitive drums **101** and the secondary transfer roller **108** are also illustrated). The intermediate transfer unit **200** includes the intermediate transfer belt **106** as an intermediate transfer member. In this embodiment, the intermediate transfer belt **106** is an endless belt (film) formed of polyimide. The material of the intermediate transfer belt **106** is not limited to polyimide, and may be a resin such as PVDF (polyvinylidene fluoride), polyamide, PET (polyethylene terephthalate), or polycarbonate. The intermediate transfer belt **106** is supported by five support rollers including a drive roller **201**, a tension roller **204**, an auxiliary roller **205**, an idler roller **202**, and a secondary transfer opposing roller **203** in a tensioned state.

Four photosensitive drums **101** are arranged in a substantially straight line extending in the conveyance direction of the intermediate transfer belt **106**. In this embodiment, the four photosensitive drums **101** are arranged in a substantially horizontal direction. More specifically, in this embodiment, the four photosensitive drums **101** are arranged in a substantially straight line such that a common tangent line on a side adjacent to the intermediate transfer unit **200** extends in a substantially horizontal direction.

The drive roller **201** is rotated by a belt drive motor **270** (FIG. **3**) as a drive source and rotates (circulates or moves) the intermediate transfer belt **106** in the direction indicated by the arrow R2 in FIG. **2**. The surface of the drive roller **201** is formed of a rubber layer having a high friction coefficient so as to prevent the intermediate transfer belt **106** from slipping. The drive roller **201** also functions as a steering roller for correcting the belt deviation, which is described in detail later. A structure for supporting the drive roller **201** is described in detail later.

The tension roller **204** is rotatably supported by bearings **207** at end portions in a rotational axis direction thereof. The bearings **207** are attached to a frame **240**, which is described later, in a movable manner in a direction indicated by an arrow A in FIG. **2** (direction from the inner surface side of the intermediate transfer belt **106** toward the outer surface side, or the opposite direction). The bearings **207** are each biased by a tension spring **208**, which is a biasing unit, from the inner surface side of the intermediate transfer belt **106** toward the outer surface side. Thus, the tension roller **204** is biased from the inner surface side of the intermediate transfer belt **106** toward the outer surface side so as to apply a pressure to the inner surface of the intermediate transfer belt **106**. In this embodiment, the tension spring **208** is a compressed coil spring, which is an elastic member, and is disposed between the bearings **207** and a supporting surface of the frame **240** in a compressed state. The tension roller **204** is described further in detail later.

The auxiliary roller **205** and the idler roller **202** provide an image transfer surface G therebetween. The image transfer surface G, to which the toner image is transferred from the photosensitive drums **101**, extends substantially in a planer shape. The auxiliary roller **205** is rotatably supported by the frame **240** at end portions in a rotational axis direction thereof by using bearings (not illustrated).

The idler roller **202** and the auxiliary roller **205** provide the image transfer surface G therebetween. The idler roller **202** is rotatably supported by the frame **240** at end portions in the rotational axis direction thereof by using bearings (not illustrated).

The secondary transfer opposing roller (secondary transfer inner roller) **203** and the secondary transfer roller (secondary transfer outer roller) **108** provide the secondary transfer portion N2 with the intermediate transfer belt **106** being sandwiched therebetween. The secondary transfer opposing roller **203** is rotatably supported by the frame **240** at end portions in the rotational axis direction by using bearings (not illustrated).

The intermediate transfer unit **200** includes the above-described primary transfer rollers **105**Y, **105**M, **105**C, and **105**K. The primary transfer rollers **105**Y, **105**M, **105**C, and **105**K are disposed so as to face the corresponding photosensitive drums **101**Y, **101**M, **101**C, and **101**K with the intermediate transfer belt **106** therebetween. The primary transfer rollers **105** are disposed between the auxiliary roller **205** and the idler roller **202** in the conveyance direction of the intermediate transfer belt **106**. The primary transfer rollers **105** are each rotatably supported by bearings **210**, which are rotatably attached to the frame **240**, at end portions in the rotational axis direction. The bearings **210** are each biased against the photosensitive drum **101** by a primary transfer spring **209**, which is a biasing unit. In this embodiment, the primary transfer spring **209** is a compressed coil spring, which is an elastic member, and is disposed between the frame **240** and the bearing **210** in a compressed state. The primary transfer rollers **105** and the corresponding photosensitive drums **101** sandwich the intermediate transfer belt **106** and provide the primary transfer portions N1 therebetween.

3. Steering Mechanism

Next, a steering mechanism is described. The steering mechanism is configured to correct the position of the intermediate transfer belt **106** in the width direction (hereinafter, may be simply referred to as a belt position), which is displaced due to the belt deviation, such that the belt position is brought back to a substantially middle position.

In this embodiment, the drive roller **201**, which rotates the intermediate transfer belt **106**, also functions as a steering roller, which is one of the plurality of support rollers supporting the intermediate transfer belt **106** in a tensioned state. The steering roller is configured to tilt with respect to the other support rollers to correct the belt position. However, the present invention is not limited to the configuration in which the steering roller is the drive roller. For example, in a supporting structure similar to that in FIG. **2**, the idler roller **202** or the secondary transfer opposing roller **203** may be used as the drive roller such that the steering roller and the drive roller are different support rollers.

FIG. **3** is a schematic perspective view of the drive roller (hereinafter, referred to as a steering roller) **201** and peripheral portions thereof viewed from the front side (the intermediate transfer belt **106** is not illustrated). FIG. **4**A is a schematic perspective view of a steering drive unit **250**, which is described later, and peripheral portions thereof viewed from the front side. FIG. **4**B is a schematic perspective view of the steering drive unit **250** and peripheral portions thereof viewed from the rear side. In FIGS. **4**A and **4**B, the intermediate transfer belt **106** are not illustrated.

In this embodiment, a steering mechanism **260** controls the belt position by changing the position of the steering roller **201** with respect to the secondary transfer opposing roller **203** (first roller). A front end portion of the steering roller **201** in the rotational axis direction is rotatably supported by the frame **240** with a bearing (not illustrated) therebetween. In addition, a rear end portion of the steering roller **201** in the rotational axis direction is rotatably supported by a steering arm **223**, which is a supporting member, with a bearing therebetween. The steering arm **223** is supported by the frame **240** in a turnable (swingable) manner about a turn shaft **228** positioned on a rear side surface of the frame **240**. In addition, an eccentric cam **222** is disposed on the rear side surface of the frame **240**. The steering arm **223** is biased so as to be in contact with the eccentric cam **222**. A steering motor **220**, which is a drive source, rotates the eccentric cam **222** through a steering cam shaft **227**. The steering arm **223** is turned when the eccentric cam **222** is rotated. The angular position of the steering arm **223** in the turning direction is determined by the stop position of the eccentric cam **222**. In this way, the steering arm **223** moves the end portion of the steering roller **201**, which is positioned on the rear side in the rotational axis direction, in the up-down direction on the predetermined tilting trajectory (substantially arc shape). This configuration enables the steering roller **201** to tilt about the bearing, which supports the end portion on the front side in the rotational axis direction, on the predetermined tilting trajectory. In this embodiment, the steering motor **220**, the steering cam shaft **227**, and the eccentric cam **222** constitute the steering drive unit **250**.

The intermediate transfer unit **200** further includes a belt position detection mechanism **230** to detect the belt position. In this embodiment, the belt position detection mechanism **230** includes a sensor flag portion (hereinafter, simply referred to as a flag) **224** and a sensor **226** including a plurality of transmissive photointerrupters. The flag **224** is supported in a turnable (swingable) manner about a flag rotation shaft **224***c*. The flag **224** has a contact portion **224***a* at its one end and a light blocking portion **224***b*, which blocks a light of the photointerrupter in the sensor **226** depending on the angular position in the turn direction of the flag **224**, at the other end. The flag **224** is biased by a torsion coil spring **225**, which is an elastic member as a biasing unit, such that the contact portion **224***a* is turned so as to come in contact with a front end surface (edge) of the intermediate transfer belt **106**. When the belt deviation is caused by the traveling of the intermediate transfer belt **106**, the flag **224** turns in connection with the displacement of the intermediate transfer belt **106**. The turn of the flag **224** is detected by the sensor **226**. In other words, the flag **224** blocks the light of the photointerrupters of the sensor **226** in accordance with the belt position, and a combination of output signals from the photointerrupter of the sensor changes. A control unit **251** activates the steering motor **220** to rotate the eccentric cam **222** based on the output signals, causing the steering arm **223** to turn. This enables the steering roller **201** to be tilted on the tilting trajectory defined by the steering arm **223** such that the intermediate transfer belt **106** moves in the width direction back to substantially the middle position.

FIGS. **5**A to **5**C are schematic perspective views illustrating an operation of the steering mechanism **260**. FIG. **5**A indicates a state in which the belt position is positioned at substantially the middle. FIG. **5**B indicates a state in which the belt position is displaced to the rear side. FIG. **5**C indicates a state in which the belt position is displaced to the front side. As illustrated in FIG. **5**B, if the belt position is displaced to the rear side, the rear end portion of the steering roller **201** is moved in the direction indicated by an arrow C1 (downwardly) in FIG. **4**B. This moves the intermediate transfer belt **106** to the front side as indicated by an arrow B1 in FIGS. **4**A and **4**B and FIG. **5**B. In addition, if the belt position is displaced to the front side as illustrated in FIG. **5**C, the rear end portion of the steering roller **201** is moved in a direction indicated by an arrow C2 (upwardly) in FIG. 4B. This moves the intermediate transfer belt **106** to the rear side as indicated by an arrow B2 in FIGS. 4A and 4B and FIG. 5C. As described above, since the steering mechanism **260** causes the steering roller **201** to tilt based on the detection result of the belt position detection mechanism **230**, the belt position is corrected to the substantially middle.

In this embodiment, the steering arm **223**, the steering drive unit **250**, the belt position detection mechanism **230**, and the control unit **251**, for example, constitute the steering mechanism **260**.

In this embodiment, a distance between the secondary transfer opposing roller **203** and the steering roller **201** in the conveyance direction of the intermediate transfer belt **106** is longer than the width of the intermediate transfer belt **106** regardless of the tilting amount (titling angle) of the steering roller **201**. In addition, in this embodiment, the tilting trajectory of the steering roller **201** is set such that the rotational axes of the support rollers other than the steering roller **201** are arranged substantially parallel to each other regardless of the tilting amount (tilting angle) of the steering roller **201**. Here, "substantially parallel" includes a state in which the angle defined between the rotational axis of the tension roller **204** and the rotational axis of each support roller **202** and **203**, which are support rollers other than the steering roller **201** and the tension roller **204**, is 5 degrees or less. In this embodiment, one end portion of the steering roller **201** is supported in a turnable manner about the axis intersecting (in this embodiment, substantially perpendicular to) the rotation axis of the steering roller **201**. In addition, in this embodiment, another end portion of the steering roller **201** is supported in a rotatable manner by the steering arm **223**, which is turnable about the axis substantially perpendicular to the rotation axis of the secondary transfer opposing roller **203**. This configuration enables the other end of the steering roller **201** to move on the arc-like movement trajectory. In particular, in this embodiment, the tilting trajectory (the movement trajectory of the above-described other end is described as an example) extends in the direction described below. The movement trajectory extends, when viewed in the width direction of the intermediate transfer belt **106**, in a direction intersecting both of a surface of the intermediate transfer belt **106** between the secondary transfer opposing roller **203** and the steering roller **201** and a surface of the intermediate transfer belt **106** between the steering roller **201** and the tension roller **204**.

4. Tension Roller

Next, the tension roller **204** is described further in detail. FIG. 6A is a perspective view of the tension roller **204**. FIG. 6B is a cross-sectional view of the tension roller **204**.

The tension roller **204** (second roller) is a reverse crown roller, which has a reverse crown shape in which each end portion in the rotational axis direction has a larger outer diameter than a middle portion. More specifically, in this embodiment, the tension roller **204** is a reverse crown roller having a reverse crown shape having an outer diameter gradually increases from the middle toward each end in the rotational axis direction by a constant radius. The reverse crown amount is indicated by (**ϕd1**−**ϕd2**), which is a difference between the maximum outer diameter and the minimum outer diameter, where **ϕd1** is the maximum outer diameter (an outer diameter of the end portion) of the tension roller **204** and **ϕd2** is the minimum outer diameter (an outer diameter of the middle portion).

In FIGS. 6A and 6B, the reverse crown shape are exaggerated. Here, the middle portion and the end portions of the tension roller **204** are middle and end portions in the rotational axis direction of the tension roller **204** in an area of the tension roller **204** to be in contact with (wound around) the intermediate transfer belt **106**.

The tension roller **204** is disposed adjacent to and downstream of the steering roller (upstream roller) **201** in the conveyance direction of the intermediate transfer belt **106**. The tension roller **204** biases (presses) against the intermediate transfer belt **106** from the inner surface side toward the outer surface side at the both end portions in the rotational axis direction. With this configuration, the tension roller **204** applies tension to the intermediate transfer belt **106** to eliminate the difference in the circumferential length of the intermediate transfer belt **106** in the width direction, which is caused by the tilting of the steering roller **201**.

FIG. 7 is a schematic view indicating a tension distribution in a surface of the intermediate transfer belt **106** extending between the secondary opposing roller **203** and the tension roller **204** when the steering roller **201** is tilted in the direction indicated by the arrow C1 in FIG. 4B in this embodiment. In FIG. 7, the intermediate transfer belt **106** is exploded in the conveyance direction thereof.

In addition, FIG. 8, which corresponds to FIG. 7, is a schematic view of a comparative example which employs a cylindrical (straight) tension roller **204** having substantially a constant outer diameter over the entire length in the rotational axis direction. The intermediate transfer unit **200** of the comparative example has a configuration substantially identical to that of the first embodiment except for the tension roller **204** above-described configuration. The components of the comparative example identical to those of the first embodiment are assigned the same reference numerals as those of the first embodiment.

The steering roller **201** may be tilted in a direction indicated by the arrow C1 in FIG. 4B to move the belt position in a direction indicated by an arrow B1 in FIG. 7 and FIG. 8. Such a case is discussed. In such a case, tension T1 applied by the steering roller **201** is higher toward a downstream side in the movement direction of the belt position (lower side in FIG. 7 and FIG. 8). The larger the tilting amount of the steering roller **201**, the larger the difference in the tension T1 in the width direction of the intermediate transfer belt **106**. Tension T2, which is applied to a position around the secondary transfer opposing roller **203**, is substantially evenly distributed in the width direction of the intermediate transfer belt **106**.

As illustrated in FIG. 8, when the tension roller **204** is straight (comparative example), tension T3, which is applied to a portion of the intermediate transfer belt **106** close to the tension roller **204**, is substantially evenly distributed in the width direction of the intermediate transfer belt **106**. Thus, the stretched surface of the intermediate transfer belt **106** between the steering roller **201** and the secondary transfer opposing roller **203** has a difference in the distribution of the tension, which is applied in the conveyance direction of the intermediate transfer belt **106**, at end portions in the width direction of the intermediate transfer belt **106**. As a result, a radial wave W is generated to extend from a portion of the stretched surface adjacent to the steering roller **201**, at which the tension is high (lower side in FIG. 8), toward an upstream side in the conveyance direction of the intermediate transfer belt **106**, and thus the stretched surface has an area X where the tension is low. In particular, the wave W tends to have a higher and steeper shape as the length of the stretched surface in the direction of tension, i.e., the length of the intermediate transfer belt **106** in the conveyance direction, is longer than the width of the intermediate transfer belt **106**.

Contrary to this, as illustrated in FIG. **7**, when the tension roller **204** has a reverse crown shape (the embodiment of the present invention), the tension T**3** applied by the tension roller **204** is higher at end portions in the rotational axis direction of the tension roller **204**, which have the larger outer diameter, than at the middle portion in the rotational axis direction. With this configuration, the difference in tension in the width direction of the intermediate transfer belt **106** at a portion close to the steering roller **201** is smaller than that in the case of FIG. **8**. In addition, this configuration has a smaller area X, where the tension in the stretched surface of the intermediate transfer belt **106** between the steering roller **201** and the secondary transfer opposing roller **203** is low, than in the case of FIG. **8**. As a result, the occurrence of the wave W, which is caused in the stretched surface by the tilting of the steering roller **201**, is suppressed. Thus, the buckling of the portion of the intermediate transfer belt **106** to be wound around the steering roller **201** is reduced, reducing the image defect due to the bent intermediate transfer belt **106**. Here, as illustrated in FIG. **7**, in the end portion (lower portion in FIG. **7**) in the width direction of the intermediate transfer belt **106**, where the tension T**1** is high, the tension T**3** is also high compared to the middle portion. However, in the configuration illustrated in FIG. **7**, the ratio of the distribution of the tension T**3** with respect to the tension T**1** is more equalized than in the case of FIG. **8**. Thus, the configuration illustrated in FIG. **7** has the above-described advantages.

The waving is more suppressed as the reverse crown amount (ϕd**1**−ϕd**2**) is larger. However, if the reverse crown amount is too large, it is difficult to wind the intermediate transfer belt **106** around the tension roller **204** over the entire area in the width direction of the intermediate transfer belt **106**. In addition, in general, if a support roller for supporting the belt in a tensioned state having a reverse crown shape is employed, the shape increases the deviation amount of the belt when the belt is displaced to one side in the width direction. Thus, if the reverse crown amount of the tension roller **204** is too large, the belt deviation may be difficult to be corrected by the tilting of the steering roller **201**. In view of this, the reverse crown amount of the tension roller **204** can be about a few hundred μm (200 μm to 600 μm, for example) when the length in the rotational axis direction of the tension roller **204** is 350 mm, the outer diameter of the end portion in the rotational axis direction is ϕ20 mm. In this embodiment, the length in the rotational axis direction of the tension roller **204** and the outer diameter of the end portion in the rotational axis direction are described as above, and the reverse crown amount is 400 μm.

As described above, in this embodiment, the tilting of the steering roller **201** causes the tension roller **204** to correct the difference in the circumferential length of the intermediate transfer belt **106** in the width direction of the intermediate transfer belt **106**. In addition, the reverse crown shape of the tension roller **204** reduces the difference in tension of the stretched surface, which is positioned upstream of the steering roller **201** in the conveyance direction of the intermediate transfer belt **106**, over the area in the width direction, reducing the occurrence of the waving in the stretched surface. With this configuration, the belt position is properly corrected by the steering roller **201**, and the buckling of the intermediate transfer belt **106** at the portion to be wound around the steering roller **201** is suppressed, and thus the high image quality is obtained. According to this embodiment, the waving of the intermediate transfer belt **106** due to the difference in the tension in the width direction of the intermediate transfer belt **106**, which is caused by the tilting of the steering roller **201**, is reduced.

## Second Embodiment

Next, another embodiment of the present invention is described. The basic configuration and operation of the image forming apparatus according to this embodiment are identical to those of the first embodiment. Thus, the components of the image forming apparatus in this embodiment having the functions and configurations identical or corresponding to those of the image forming apparatus in the first embodiment are assigned the same reference numerals as those of the image forming apparatus in the first embodiment, and are not described in detail.

### 1. Effect of Reverse Crown Shape of Tension Roller on Color Misalignment

An effect of the reverse crown shape of the tension roller **204** on the color misalignment is described.

FIG. **12** is a schematic view indicating a relationship between expansion and contraction of the intermediate transfer belt **106** and the image at the image transfer surface (primary transfer surface) G in the configuration of the first embodiment. In FIG. **12**, the intermediate transfer belt **106** is exploded in the conveyance direction thereof, and the image transfer surface G is viewed from below. The effect due to the reverse crown shape of the tension roller **204** is exaggerated. In FIG. **12**, broken lines indicate changes in the expansion and contraction of the intermediate transfer belt **106** in the conveying process of the intermediate transfer belt **106**, and double lines indicate changes in the yellow image in the conveying process. Here, the image is a straight line extending in the rotational axis direction (main scanning direction) of the photosensitive drum **101**.

The tension of the image transfer surface G of the intermediate transfer belt **106** in the width direction is desired to be substantially constant while the intermediate transfer belt **106** is travelling, so as to reduce an image defect such as color misalignment. However, since the intermediate transfer belt **106** changes its shape to fit the reverse crown shape of the tension roller **204**, the front side, the rear side, and the middle in the width direction of the intermediate transfer belt **106** may be different in the amount of expansion and contraction in the conveyance direction as illustrated in FIG. **12**. The primary transfer portion for yellow N1Y, which is closest to the tension roller **204** in the conveyance direction of the intermediate transfer belt **106**, has the largest difference in the expansion and contraction, and the difference becomes smaller as closer to the downstream side. Thus, the image transferred from the photosensitive drum for yellow **101**Y to the intermediate transfer belt **106** gradually curves with the changes in the expansion and contraction of the intermediate transfer belt **106** until reaches the primary transfer portion for black N1K.

Since the image transferred from the photosensitive drum for black **101**K to the intermediate transfer belt **106** is a straight line, the position of the yellow image and the position of the black image are misaligned at the middle in the width direction of the intermediate transfer belt **106**. The color misalignment in a direction (sub scanning direction) substantially perpendicular to the conveyance direction of the intermediate transfer belt **106** occurs in this way.

To reduce the color misalignment in the above-described sub scanning direction, this embodiment employs a crown roller as the auxiliary roller **205**.

2. Auxiliary Roller

Next, the auxiliary roller **205** (third roller) is described further in detail. FIG. **9**A is a perspective view of the auxiliary roller **205** in this embodiment, and FIG. **9**B is a cross-sectional view of the auxiliary roller **205** in this embodiment.

The auxiliary roller (downstream roller) **205** is disposed adjacent to and downstream of the tension roller **204** and upstream of the image transfer surface G in the conveyance direction of the intermediate transfer belt **106**. More specifically, in the conveyance direction of the intermediate transfer belt **106**, the auxiliary roller **205** is disposed adjacent to and downstream of the tension roller **204** and upstream of the primary transfer portion N**1**Y, which is the most upstream one of the primary transfer portions N**1**. In this embodiment, the auxiliary roller **205** is a crown roller having a crown shape in which end portions in the rotational axis direction each have a smaller outer diameter than the middle portion. More specifically, in this embodiment, the auxiliary roller **205** is a crown roller having a crown shape having an outer diameter gradually decreases from the middle toward each end in the rotational axis direction by a constant radius. The crown amount is indicated by ($\phi$d**4**−$\phi$d**3**), which is a difference between the maximum outer diameter and the minimum outer diameter, where $\phi$d**3** is the minimum outer diameter (an outer diameter of the end portion) of the auxiliary roller **205** and $\phi$d**4** is the maximum outer diameter (an outer diameter of the middle portion).

In FIGS. **9**A and **9**B, the crown shape are exaggerated. Here, the middle portion and the end portions of the auxiliary roller **205** are middle and end portions in the rotational axis direction of the auxiliary roller **205** in an area of the auxiliary roller **205** to be in contact with (wound around) the intermediate transfer belt **106**.

FIG. **10** indicates a tension distribution in the intermediate transfer belt **106** at a portion close to the image transfer surface G in a case in which the auxiliary roller **205** is a crown roller. In FIG. **10**, the intermediate transfer belt **106** is exploded in the conveyance direction thereof, and the image transfer surface G is viewed from above. When the auxiliary roller **205**, which is a crown roller, sends the intermediate transfer belt **106**, tension T**4** applied to the intermediate transfer belt **106** is high at the middle portion of the auxiliary roller **205** in the rotational axis direction. Thus, the difference in the tension T**3** applied by the tension roller **204**, which is the reverse crown roller, in the width direction of the intermediate transfer belt **106** is eliminated by the distribution of the tension T**4** applied by the auxiliary roller **205**. With this configuration, the difference in the tension on the image transfer surface G in the width direction of the intermediate transfer belt **106** is reduced even when the tension roller **204**, which is disposed upstream of the image transfer surface G in the conveyance direction of the intermediate transfer belt **106**, has the reversed crown shape, leading to a reduction in the image defect such as color misalignment. Hereinafter, this is described further in detail.

The crown amount of the auxiliary roller **205** is desired to be set such that the reverse crown shape of the tension roller **204** sufficiently eliminates the difference in the expansion and contraction of the intermediate transfer belt **106** in the width direction, which is caused by the reverse crown shape of the tension roller **204**. In this embodiment, since the tension roller **204** is biased by the tension spring **208** at each end portion in the rotational axis direction, the tension roller **204** warps a little. Thus, the difference in the expansion and contraction of the intermediate transfer belt **106** in the width direction tends to be larger than the reverse crown amount of the tension roller **204**. Thus, the crown amount of the auxiliary roller **205** can be set to be larger than the reverse crown amount of the tension roller **204**. In this embodiment, the reverse crown amount of the tension roller **204** is 400 μm, and the crown amount of the auxiliary roller **205** is 500 μm.

FIG. **11** is a schematic view indicating a relationship between the expansion and contraction of the intermediate transfer belt **106** and the image at the image transfer surface G. In FIG. **11**, the intermediate transfer belt **106** is exploded in the conveyance direction thereof, and the image transfer surface G is viewed from below. The effect due to the reverse crown shape of the tension roller **204** and the crown shape of the auxiliary roller **205** is exaggerated. In FIG. **11**, broken lines indicate changes in the expansion and contraction of the intermediate transfer belt **106** in the conveying process of the intermediate transfer belt **106**, and double lines indicate changes in the yellow image in the conveying process. Here, the image is a straight line extending in the rotational axis direction (main scanning direction) of the photosensitive drum **101**.

As illustrated in FIG. **11**, the crown shape of the auxiliary roller **205** eliminates the difference in the expansion and contraction of the intermediate transfer belt **106** in the width direction, which is caused by the reverse crown shape of the tension roller **204**, in an area between the auxiliary roller **205** and the primary transfer portion for yellow N**1**Y. This reduces the image defect such as the color misalignment due to the difference in the expansion and contraction of the intermediate transfer belt **106** in the width direction. The amount of the color misalignment reduced by the configuration in this embodiment is estimated to be 60% or more.

As described above, this embodiment reduces the waving of the intermediate transfer belt **106**, which is caused by the steering operation, and the image defect such as the color misalignment, which is caused by the difference in the expansion and contraction of the intermediate transfer belt **106** in the width direction at the image transfer surface G. Thus, this embodiment is more advantageous in the formation of a high-quality image than the first embodiment.

Others

Although the present invention has been described using the specific embodiments, the present invention is not limited to the above-described embodiments.

The above-embodiments include the four image forming sections, but the number of the image forming sections is not limited to four and may be more than or less than four. In addition, the alignment sequence of the image forming sections for yellow, magenta, cyan, and black is not limited to that in the above-described embodiments.

In addition, in the above-described embodiments, the intermediate transfer belt is supported by the five support rollers in a tensioned state. However, the number of the support rollers used to support the intermediate transfer belt in a tensioned state is not limited to five, and may be more than or less than five.

In addition, in the above-described embodiments, the image transfer surface is provided between the auxiliary roller (downstream roller) and the idler roller, which is positioned upstream of the secondary transfer opposing roller (upstream roller) in the conveyance direction of the intermediate transfer belt, but the present invention is not limited to this configuration. For example, the image transfer surface may be provided between the auxiliary roller (downstream roller) and the secondary transfer opposing roller (upstream roller). In addition, in the above-described embodiments, the auxiliary roller is disposed adjacent to and downstream of the tension roller in the conveyance direction of the intermediate transfer belt, but the present invention is not limited to this configuration. An additional support roller may be disposed between the tension roller and the auxiliary roller (downstream roller). For example, an auxiliary roller (downstream roller) having a crown shape may be disposed downstream of the tension roller in the conveyance direction of the intermediate transfer belt and upstream of the primary transfer portion (specifically, the most upstream one of the primary transfer portions). This configuration provides the same advantage as that in the second embodiment.

In addition, in the above-described embodiments, the image forming apparatus using the intermediate transfer process is described as an example, but the present invention is applicable to an image forming apparatus using a direct transfer process. FIG. **13** is a schematic cross-sectional view of the main components of an image forming apparatus using a direct transfer process. In FIG. **13**, the components having the functions and configurations identical or corresponding to those of the image forming apparatus illustrated in FIG. **1** are assigned the same reference numerals as those in FIG. **1**. An image forming apparatus **100** in FIG. **13** includes a recording material carrying belt **160**, which is an endless belt as a recording material carrier, instead of the intermediate transfer belt **106** of the image forming apparatus **100** in FIG. **1**. In the image forming apparatus **100** in FIG. **13**, the toner image formed on the photosensitive drum **101** at each image forming section S is transferred to the recording material P, which is carried and conveyed by the recording material carrying belt **160**, at each transfer portion N. In such an image forming apparatus **100** using the direct transfer process, it is desired to prevent the recording material carrying belt **160** from having a crease, which is caused by the waving due to the steering operation, so as to properly convey the recording material P. In addition, it is desired to reduce the difference in expansion and contraction of the recording material carrying belt **160** in the width direction on the image transfer surface G so as to properly transport the recording material P on the image transfer surface (recording material carrying surface) G. Therefore, the waving and the difference in the expansion and contraction are reduced in the image forming apparatus **100** using the direct transfer process by employing the configurations in the above-described first and second embodiments. In addition, the present invention is applicable to a belt conveyance apparatus, in which a belt is a photosensitive belt or an electrostatic recording dielectric belt, and to an image forming apparatus including the belt conveyance apparatus.

While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

This application claims the benefit of Japanese Patent Application No. 2015-171507, filed Aug. 31, 2015, which is hereby incorporated by reference herein in its entirety.

What is claimed is:

**1**. A belt conveyance apparatus comprising:

an endless belt carrying a toner image; and

a plurality of support rollers supporting the endless belt from an inner surface side of the endless belt in a tensioned state, the plurality of support rollers including a steering roller, a first roller, and a second roller, wherein

the steering roller is configured to move the endless belt in a width direction of the endless belt intersecting a traveling direction of the endless belt when tilted with respect to the first roller,

the first roller is disposed adjacent to and upstream of the steering roller in the traveling direction, and

the second roller is disposed adjacent to and downstream of the steering roller in the traveling direction, the second roller having a reverse crown shape in which end portions in a rotational axis direction each have a larger outer diameter than a middle portion.

**2**. The belt conveyance apparatus according to claim **1**, wherein an area of the endless belt extending between the first roller and the steering roller has a length in the traveling direction larger than a length of the endless belt in the width direction.

**3**. The belt conveyance apparatus according to claim **1**, wherein rotational axes of the first roller and the second roller are substantially parallel to each other.

**4**. The belt conveyance apparatus according to claim **1**, wherein the steering roller has an end portion in a rotational axis direction supported in a turnable manner about an axis intersecting a rotational axis of the steering roller and another end portion supported in a rotatable manner by a supporting member.

**5**. The belt conveyance apparatus according to claim **1**, wherein the plurality of support rollers include a third roller disposed adjacent to and downstream of the second roller in the traveling direction, and

the third roller has a crown shape in which end portions in the rotational axis direction each have a smaller outer diameter than a middle portion.

**6**. The belt conveyance apparatus according to claim **5**, wherein a crown amount of the crown shape of the third roller is larger than a reverse crown amount of the reverse crown shape of the second roller.

**7**. The belt conveyance apparatus according to claim **1**, wherein the steering roller is configured to apply a driving force to the endless belt when rotated.

**8**. An image forming apparatus comprising:

an endless belt;

a toner image forming unit configured to form a toner image on the endless belt; and

a plurality of support rollers supporting the endless belt from an inner surface side of the endless belt in a tensioned state, the plurality of support rollers including a steering roller, a first roller, and a second roller, wherein

the steering roller is configured to move the endless belt in a width direction of the endless belt intersecting a traveling direction of the endless belt when tilted with respect to the first roller,

the first roller is disposed adjacent to and upstream of the steering roller in the traveling direction, and

the second roller is disposed adjacent to and downstream of the steering roller in the traveling direction, the second roller having a reverse crown shape in which end portions in a rotational axis direction each have a larger outer diameter than a middle portion.

**9**. The image forming apparatus according to claim **8**, wherein an area of the endless belt extending between the first roller and the steering roller has a length in the traveling direction larger than a length of the endless belt in the width direction.

**10**. The image forming apparatus according to claim **8**, wherein rotational axes of the first roller and the second roller are substantially parallel to each other.

**11**. The image forming apparatus according to claim **8**, wherein the steering roller has an end portion in a rotational axis direction supported in a turnable manner about an axis intersecting a rotational axis of the steering roller and another end portion supported in a rotatable manner by a supporting member.

**12**. The image forming apparatus according to claim **8**, wherein the plurality of support rollers include a third roller disposed adjacent to and downstream of the second roller in the traveling direction, and

the third roller has a crown shape in which end portions in the rotational axis direction each have a smaller outer diameter than a middle portion.

**13**. The image forming apparatus according to claim **12**, wherein a crown amount of the crown shape of the third roller is larger than a reverse crown amount of the reverse crown shape of the second roller.

**14**. The image forming apparatus according to claim **8**, wherein the steering roller is configured to apply a driving force to the endless belt when rotated.

**15**. The image forming apparatus according to claim **1**, further comprising:

bearing members configured to rotatably support the second roller by respectively being provided to either end of the second roller in the width direction; and

a biasing member configured to bias each of the bearing members,

wherein the second roller is biased by the biasing member from the inner surface side of the endless belt toward the outer surface side.

**16**. The image forming apparatus according to claim **8**, further comprising:

bearing members configured to rotatably support the second roller by respectively being provided to either end of the second roller in the width direction; and

a biasing member configured to bias each of the bearing members,

wherein the second roller is biased by the biasing member from the inner surface side of the endless belt toward the outer surface side.

**17**. A belt conveyance apparatus comprising:

an endless belt carrying a toner image; and

a plurality of support rollers supporting the endless belt from an inner surface side of the endless belt in a tensioned state, the plurality of support rollers including a steering roller, a first roller, and a second roller, wherein

the steering roller is configured to move the endless belt in a width direction of the endless belt intersecting a traveling direction of the endless belt when tilted with respect to the first roller,

the first roller is disposed adjacent to and upstream of the steering roller in the traveling direction, and

the second roller is disposed adjacent to and downstream of the steering roller in the traveling direction, the second roller being smaller in diameter at a central portion than at an end portion in the endless belt contact region thereof with respect to a rotational axis direction thereof.

**18**. The image forming apparatus according to claim **17**, wherein the steering roller is configured to apply a driving force to the endless belt when rotated.

**19**. The image forming apparatus according to claim **17**, further comprising:

bearing members configured to rotatably support the second roller by respectively being provided to either end of the second roller in the width direction; and

a biasing member configured to bias each of the bearing members, wherein the second roller is biased by the biasing member from the inner surface side of the endless belt toward the outer surface side.

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